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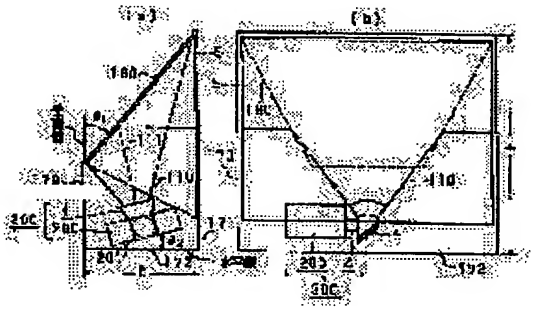
(54) PROJECTION TYPE DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a compact projection type display device.
SOLUTION: A projection lens 4 is provided with first, second and third lens groups respectively having negative, positive and the positive refracting power in turn from a screen 5 side and constituted so as to satisfy three conditions being 1.8<D1/f<3.0, 1.1<f2/f3<1.6 and 1.5<|f1 /f<2.3 (D1 is a distance between the first and the second lens groups and f1, f2, f3 and (f) are the focal distances of the first, the second and the third lens groups and the whole system). Besides, a mirror 41 is arranged between the first and the second lens groups. Then, projection light raised by the mirror 41 incorporated in the lens 4 is made incident on a screen 5 by the other mirror 160. A projector 300 is installed in a left half area from the center of the screen 5.



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CLAIMS

[Claim(s)]

[Claim 1] Have the following and a portion before the 1st [of said projection means / said] mirror is mounted in a 1 side side rather than a center section of said screen. A projection mold display characterized by constituting in order to bend the optical path to an abbreviation horizontal direction by said 2nd mirror and to carry out incidence to said screen, after projection light by which outgoing radiation was carried out to parallel from said projection means in a field of said screen is risen to abbreviation above by said 1st mirror. A projection means which carries out amplification projection of the image which contained an image display device and was displayed on this image display device A projection lens prepared in the outgoing radiation section of this projection means The 1st mirror which is prepared in the interior of this projection lens, and reflects light A cabinet which projection light reflected by the 2nd mirror which reflects projection light by which outgoing radiation was carried out from said projection lens, and this 2nd mirror carries out incidence, and contains a screen and said projection means of a transparency mold which forms an amplification image, and holds said 2nd mirror and a screen

[Claim 2] A projection mold display according to claim 1 characterized by constituting the direction of said image display device corresponding to a horizontal direction of said screen in agreement in the direction of a center line of outgoing radiation light from said projection lens.

[Claim 3] Have the following and said case is mounted in a 1 side side rather than a center section of said screen. After projection light by which outgoing radiation was carried out to parallel from said projection means in a field of said screen is risen to abbreviation above by said 1st mirror, It is constituted in order to bend the optical path to an abbreviation horizontal direction by said 2nd mirror and to carry out incidence to said screen. A flat surface where optical system of a portion before the 1st [of said projection means / said] mirror is arranged on the same flat surface which intersects perpendicularly with a main beam of light of outgoing radiation light of said projection lens, and this optical system is arranged, and the base section of said case prepared in abbreviation parallel, A projection mold display characterized by setting an angle theta with the base section of said cabinet to make as predetermined angle within the limits. A projection means which carries out amplification projection of the image which contained an image display device and was displayed on this image display device A projection lens prepared in the outgoing radiation section of this projection means A case holding optical system before said projection lens of said projection means A cabinet which is prepared in the interior of said projection lens, projection

light reflected by the 1st mirror which reflects light, the 2nd mirror which reflects projection light by which outgoing radiation was carried out from said projection lens, and said 2nd mirror carries out incidence, and contains a screen of a transparency mold which forms an amplification image, and said case, and holds said 2nd mirror and a screen

[Claim 4] A projection mold display according to claim 3 characterized by forming a drawing means to restrict an acceptance angle of the flux of light by which outgoing radiation is carried out from said image display device in the interior of said projection lens.

[Claim 5] A projection mold display according to claim 3 characterized by satisfying conditions which it is constituted so that a main beam of light of outgoing radiation light of said projection lens may incline and carry out outgoing radiation to a back side of equipment rather than the direction of a vertical by setting out of said angle theta, and theta<=20 degrees [0 degree <=] of above theta become.

[Claim 6] Have the following, and it constitutes so that a main beam of light of projection light by which outgoing radiation is carried out from said projection lens may be bent to an abbreviation horizontal direction by said mirror and may carry out incidence to said screen. A projection mold display characterized by the base section of a flat surface where optical system of a portion before said mirror of said projection means is arranged in a flat surface which carries out an abbreviation rectangular cross with a main beam of light of outgoing radiation light of said projection lens, and this optical system is arranged, and said case prepared in abbreviation parallel being said screen and abbreviation parallel. A projection means which carries out amplification projection of the image which contained an image display device and was displayed on this image display device A projection lens prepared in the outgoing radiation section of this projection means A case holding optical system before said projection lens of said projection means A cabinet which is prepared in the interior of said projection lens, projection light by which outgoing radiation was carried out to a mirror which reflects light from said projection lens carries out incidence, and contains a screen and said projection means of a transparency mold which forms an amplification image, and holds said screen

[Claim 7] A projection mold display according to claim 6 characterized by constituting that two or more said projection means should be arranged in the shape of a matrix, and an unit screen should be formed by projection image of each projection means.

[Claim 8] A projection mold display according to claim 1, 3, or 6 characterized by having a dichroic prism made from plastics which performs composition in three primary colors just before said projection lens.

[Claim 9] A projection mold display according to claim 1, 3, or 6 characterized by using a zoom lens which can adjust a projection scale factor as said projection lens.

[Claim 10] A projection mold display with which it has the following, and an optical property in the screen has a function to change between a dispersion condition and a transparence condition, and said image display device is characterized by constituting that accommodation of a diameter of a opening of said drawing means should be made possible according to light and darkness of a display image. A projection means which carries out amplification projection of the image which contained an image display device and was displayed on this image display device A projection lens prepared in the outgoing radiation section of this projection means A drawing means to restrict an acceptance angle of the flux of light by which is prepared in the interior of this projection lens, and outgoing radiation is carried out from said image display device A screen with which projection light by which outgoing radiation is carried out from said projection lens carries out incidence, and forms an amplification image

[Claim 11] A projection mold display which is equipped with the following and characterized by constituting according to a lighting condition detected by said photosensor in order to change a diameter of a opening of said drawing means, and/or actuation power of said lamp. A projection means which carries out amplification projection of the image which contained a lamp which illuminates an image display device and this image display device, and was displayed on said image display device A projection lens which is prepared in the outgoing radiation section of this projection means, and carries out amplification projection of the display screen of said image display device A drawing means to restrict an 2F%2F%26N0001%3D124%26N0552%3D9%26N0553%3D000079" ¥t "tjitemdrw" □drawing 51□ · □ HYPERLINK "http://www4.ipdl.jpo.go.jp/cgi-bin/tro a projection lens from said image display device side A screen with which projection light by which outgoing radiation is carried out from said projection lens carries out incidence, and forms an amplification image, a motor to which a diameter of a opening of said drawing means is changed, a photosensor which outputs an electrical signal according to the amount of incident light, an amplifying circuit which amplifies an output of this photosensor, and a control circuit which generates an actuation control signal of said motor, and/or an actuation power control signal of said lamp from an output of this amplifying circuit

[Claim 12] A projection mold display according to claim 11 with which said image display device is characterized by having a function in which an optical property in the screen changes between a dispersion condition and a transparence condition according to light and darkness of a display image.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to a projection mold display.

[0002]

[Description of the Prior Art] Drawing 61 is explanatory drawing of the optical system of the conventional projection mold display which used the liquid crystal panel, for example, is equipment indicated by JP,1-120192,A. In drawing, 1 is the light source which consists of a lamp 120 and a reflecting mirror 130, and the light source 1 carries out outgoing radiation of the illumination-light bunch 2. As a lamp 120, sources of the white light, such as a metal halide lamp, a xenon lamp, and a halogen lamp, are used, for example. The reflector of a reflecting mirror 130 is a paraboloid or the spherical surface typically, and the emission center of a lamp 120 is positioned in the focal location of a paraboloid, or the center-of-curvature location of the spherical surface so that it may be well-known. Mirror 11a which carries out total reflection of dichroic mirror 14G and light which reflect dichroic mirror 14B which reflects blue glow and penetrates green and red light, and green light, and penetrate red light is arranged in the direction of outgoing radiation of the illumination-light bunch 2. Mirror 11c which carries out total reflection of the light is arranged in the reflective direction of dichroic mirror 14B, and liquid crystal panel 3B is prepared in the reflective direction of mirror 11c. Liquid crystal panel 3G are prepared in the reflective direction of dichroic mirror 14G. Mirror 11b which carries out total reflection of the light is arranged in the reflective direction of mirror 11a, and liquid crystal panel 3R is prepared in the reflective direction of mirror 11b. The graphic display is omitted about the actuation circuit which displays an image on liquid crystal panels 3R, 3G, and 3B. It is surrounded by these liquid crystal panels 3R, 3G, and 3B, red and blue glow are reflected selectively, the dichroic prism 15 which penetrates green light selectively is installed, and the projection lens 4 is formed in the direction of outgoing radiation of a dichroic prism 15. Each part material which constitutes the optical system before the projection lens 4 is held in the case 200, and the projection machine 300 consists of a case 200 and a projection lens 4.

[0003] Next, actuation is explained. It is decomposed into the three primary colors of red, green, and blue by dichroic mirror 14B and dichroic mirror 14G, and the illumination-light bunch 2 by which outgoing radiation was carried out from the light source 1 is irradiated by the liquid crystal panels 3R, 3G, and 3B which are bent by Mirrors 11a, 11b, and 11c, and display the monochrome image corresponding to each primary color. The flux of light modulated by the image formed in liquid crystal panels 3R, 3G, and 3B is again compounded by the one flux of light with a dichroic prism 15, is changed into the projection light

110 by the projection lens 4, and it is projected on a screen so that it may mention later. The projection lens 4 needs to amend various aberration, in order to obtain a good projection image, and it is constituted combining two or more single lenses (not shown). And focusing of the projection image on a screen drives the one section of a lens or the projection lens 4 whole which constitutes the projection lens 4 in the direction of an optical axis, and performs it.

[0004] Moreover, drawing 62 is explanatory drawing of the optical system of other projection mold displays using the conventional liquid crystal panel, for example, is equipment indicated by JP,1-157688,A. In drawing, 131 is the condensing lens prepared ahead of the light source 12, and the light source 1 is constituted from the lamp 120, the reflecting mirror 130, and the condensing lens 131 by this example. In addition, other configurations are the same as the above-mentioned conventional example (refer to drawing 61), give the same number to the same portion, and omit explanation. Moreover, since actuation is the same as that of the above-mentioned conventional example, the explanation is omitted.

[0005] Conventionally, as a projection mold display, the equipment of the frontal system which carries out image formation of the projection light which carries out outgoing radiation from a projection lens to the screen of a reflective mold, and the equipment of the rear method which a projection machine is dedicated [method] to a cabinet and carries out image formation of the projection light to the screen of a transparency mold were known. The configuration of the projection mold display of the rear method indicated by drawing 63 at JP,1-115778,U is shown. In drawing, 170 is a cabinet which contains the projection machine 300 which consists of a case 200 and a projection lens 4. The projection machine 300 is the same configuration as the projection machine 300 shown in drawing 61 or drawing 62 , and the optical system (not shown) from the light source 1 to a dichroic prism 15 is held inside the case 200. The screen 5 of a transparency mold is installed in the side attachment wall of a cabinet 170. Moreover, in the cabinet 170, the bending mirror 150,160 for leading the projection light 110 by which outgoing radiation was carried out from the projection lens 4 to a screen 5 is formed.

[0006] Next, actuation of the equipment shown in drawing 63 is described. After being reflected by the bending mirrors 150 and 160, image formation of the projection light 110 which carried out outgoing radiation of the projection lens 4 is carried out to a screen 5 as an amplification image. The bending mirror 150,160 bends the optical path from the head of the projection lens 4 to a screen 5, and it is used in order to contain optical system in a compact in a cabinet 170. And an observer 400 appreciates an amplification image from the direction of reverse in the projection machine 300 to a screen 5.

[0007]

[Problem(s) to be Solved by the Invention] Since it bends like drawing 63 in the projection mold display of the conventional rear method and the mirror 150 and the projection machine 300 are contained by the lower part of a screen 5, the portion 171 under a screen 5 is large among cabinets 170. For this reason, reduction of height H of a set was difficult. For this reason, in order to have made height H into the height and EQC of a screen mostly, the bending mirror 150,160 was omitted and the method of projecting the projection light 110 directly from screen back was used. In this case, depth D of a set became large and there was a trouble that the installation area of a cabinet 170 increased.

[0008] In addition, for the miniaturization of a set, it was effective to have shortened projection distance (main beam-of-light length from the outgoing radiation edge of the projection lens 4 to a screen 5). For this reason, the technique of extensive-cornifying the projection lens 4 was used. However, when the projection lens 4 was wide-angle-ized and the angle of divergence of the outgoing radiation light 110 was

enlarged, it bent inevitably, the mirror 150 large-sized-ized, and there was a limit in reduction of set height H.

[0009] Since a projection image becomes dark relatively and stopped being able to be visible easily when the illuminance of the screen side by outdoor daylight was higher than before, there was a demand of wanting to raise and appreciate brightness more. Conversely, when the illuminance of outdoor daylight was low, the brightness of a projection image was carried out with some prevention, raised contrast and had a demand of wanting to appreciate (lowering especially the brightness of black level more). However, in the conventional projection mold display, there was a trouble that there was no function which carries out the automatic regulation of brightness and the contrast according to the lighting condition of a location that equipment was placed.

[0010] The place which this invention is made in order to cancel the above troubles, and is made into the object is to offer the small projection mold display which reduced the depth and the height of equipment. Furthermore, other objects are to offer the small projection mold display which can make the transverse-plane size of equipment comparable as the size of a screen, and can moreover make a depth size small. Furthermore, other objects are to offer the multi-vision projection mold indicating equipment with small depth which arranged two or more small projection machines for projection mold indicating equipments in all directions.

[0011] Furthermore, other objects are to offer the projection mold display which can change the contrast ratio and brightness of a projection image, when the element which has the function in which the transparence / dispersion condition of an element change as an image display device according to the light and darkness of an image is used. Furthermore, other objects are to offer the projection mold display with which the contrast ratio and/or brightness of a projection image serve as adjustable automatically according to the brightness of the outdoor daylight on which equipment was put.

[0012]

[Means for Solving the Problem] A projection mold display concerning the 1st invention contains the 1st mirror in a projection lens, looks at a portion before the 1st [of a projection means] mirror from an equipment transverse plane, and arranges it on left-hand side [center / screen] or right-hand side, and after outgoing-radiation light of a projection lens is risen in the direction of an abbreviation vertical by the 1st mirror, a configuration that it bends to an abbreviation horizontal direction by the 2nd mirror, and incidence is carried out to a screen is made.

[0013] Moreover, in the 1st invention, in case an optical path is started by the 1st mirror, corresponding to the display direction of an image display device which should be displayed horizontally rotating on a screen, it constitutes in order to double the direction of an image display device corresponding to a horizontal direction of a screen in the direction of a center line of outgoing radiation light of a projection lens.

[0014] A projection mold display concerning the 2nd invention is equipped with the 1st and 2nd same mirror as the 1st invention. See a case which contains optical system before a projection lens of a projection means from an equipment transverse plane, and it arranges on left-hand side [center / screen] or right-hand side. A configuration of having set an angle of a flat surface where optical system before the 1st [of a projection means] mirror is arranged in a flat surface which intersects perpendicularly with a main beam of light of outgoing radiation light of a projection lens, and this optical system is arranged, the base section of a case prepared in abbreviation parallel, and the base section of a cabinet which holds a

case to make as predetermined within the limits is made.

[0015] Moreover, in the 2nd invention, an angle which both the bases section makes is set as 20 degrees or less.

[0016] A projection mold display concerning the 3rd invention has a mirror which bends an optical path in a projection lens of a projection means. Bend a main beam of light of projection light in which outgoing radiation is carried out by this mirror from a projection lens to an abbreviation horizontal direction, and it constitutes so that incidence may be carried out to a screen of a transparency mold. Optical system before a mirror of a projection means is arranged in a flat surface which carries out an abbreviation rectangular cross with a main beam of light of outgoing radiation light of a projection lens, and a configuration prepared in a flat surface where this optical system is arranged, and abbreviation parallel that the base section holding this optical system of a case serves as a screen and abbreviation parallel is made.

[0017] Moreover, in the 3rd invention, two or more projection means are arranged length and horizontally, and an unit screen is formed by projection image of each projection means, and it constitutes so that a ****** unit screen may be arranged densely.

[0018] Moreover, in invention of the 1st, and 2 or 3, a configuration equipped with a dichroic prism made from plastics which performs composition in three primary colors just before a projection lens is made.

[0019] Moreover, in invention of the 1st, and 2 or 3, a configuration which used a zoom lens which can adjust a projection scale factor as a projection lens is made.

[0020] An image display device has a function in which dispersion / transparence condition changes according to light and darkness of a display image, and a projection mold indicating equipment concerning the 4th invention makes a configuration of controlling a diameter of a opening of drawing which restricts an acceptance angle of the flux of light which carries out outgoing radiation from an image display device.

[0021] A projection mold display concerning the 5th invention detects a lighting condition of a location that equipment was placed, and makes a configuration of changing actuation power of a lamp which illuminates a diameter of a opening and/or an image display device of drawing which restrict an acceptance angle of the flux of light which carries out outgoing radiation from an image display device, according to the lighting condition.

[0022] Moreover, in the 5th invention, an image display device has a function in which dispersion / transparence condition changes according to light and darkness of a display image.

[0023] In the 1st invention, since an optical path is bent in a field which looked at from a transverse-plane center of a screen, and was seen from the inside of a field which contained most projection means in a right hand or the direction of a left hand, and was seen from a transverse plane of equipment, and a longitudinal direction of equipment unlike conventional equipment, reduction with height of equipment and depth is simultaneously realizable. And since the 1st mirror is built in the interior of a projection lens, even if it uses a wide angle projection lens, a size of the 1st mirror does not become large.

[0024] In the 2nd invention, a case holding optical system before a projection lens of a projection means is seen from a transverse-plane center of a screen, it contains in a right hand or the direction of a left hand, and the optical system is held in a flat surface parallel to a base of a projection means within a case, and since a base of a case can be arranged by base of a cabinet holding the whole equipment, and suitable angular relation-ship, height and depth of equipment can be reduced simultaneously. And since the 1st mirror is built in the interior of a projection lens, even if it uses a wide angle projection lens, a size of the

1st mirror does not become large.

[0025] a mirror which built projection light which carries out incidence to a screen in a projection lens in the 3rd invention -- horizontal -- bending -- and optical system before a projection lens -- a screen -- abbreviation -- since it can arrange in an parallel flat surface, depth of equipment can be made small, making a transverse-plane size of equipment into a screen size and an abbreviation EQC. And since a mirror is built in the interior of a projection lens, even if it uses a wide angle projection lens, a size of a mirror does not become large like [in a case of arranging a mirror after a lens].

[0026] Moreover, in the 3rd invention, since a transverse-plane size of equipment is made to a screen size and an abbreviation EQC as mentioned above, by arranging two or more projection means in all directions, and arranging densely an unit screen formed by projection light of each projection means in all directions, depth is small and a multi-vision projection mold display with a small joint between unit screens can be realized.

[0027] Moreover, if a dichroic prism for color composition is created with plastic material, such as PMMA, compared with equipment using a dichroic prism of a well-known glass material, lightweight-izing and low-pricing are conventionally possible.

[0028] Moreover, since a proportion of periodic structure of a screen and periodic structure of a projection image of a liquid crystal panel serves as adjustable by using a zoom lens which can tune a projection scale factor finely, moire on which a projection image is overlapped can be adjusted in the condition of a low check by looking which is satisfactory practically. Furthermore, even if a projection scale-factor difference between unit screens arises with a manufacture error of a lens, an arrangement error of an optic, etc. by using as a zoom lens a projection lens of each projection means to constitute a multi-vision projection mold display, adjustment for the same projection scale factor is attained.

[0029] In the 4th invention, since an acceptance angle of outgoing radiation light of an image display device with which drawing constituted by the diameter of opening adjustable is formed, and dispersion / transparence condition changes to the interior of a projection lens is made adjustable, a contrast ratio and brightness of a projection image can adjust according to liking of an observer, and can add the new function which is not in the conventional projection mold display.

[0030] In the 5th invention, since a diameter of a opening of drawing inside a projection lens is controllable according to brightness of outdoor daylight, an acceptance angle of the flux of light which carries out incidence serves as adjustable from an image display device with which dispersion / transparence condition changes, and a contrast ratio of a projection image when outdoor daylight changes, and brightness can be regulated automatically to a good condition. Furthermore, since actuation power of a lamp which illuminates an image display device according to brightness of outdoor daylight serves as adjustable, a contrast ratio can regulate automatically independently brightness of a projection image when outdoor daylight changes. By the above, the new function which is not in the conventional projection mold display can be added.

[0031]

[Embodiment of the Invention] In advance of explanation of the projection mold display of this invention, it is adopted as this equipment and a suitable retro focus mold lens is explained. In order to realize the liquid crystal projection mold display of a small rear method, the projection lens of a wide angle is required. As a lens for images of a wide angle, the wide angle lens for 1 eye reflex cameras is known conventionally. However, it uses for the liquid crystal projection mold display of this invention, and the

suitable projection lens is taking the following additional specifications into consideration to the wide angle lens for 1 eye reflex cameras.

[0032] (A) It is the configuration that air gap sufficient in a lens system is securable for bending mirror insertion.

(B) In order to insert the dichroic prism for color composition, a long back focus is securable.

(C) To a dichroic prism, if the chief ray of axial outdoor daylight leans, an irregular color will arise. Moreover, when making the illumination light into parallel light (telecentric lighting), if the chief ray of the axial outdoor daylight by the side of a liquid crystal panel leans, the F value besides a shaft will increase equivalent and the circumference quantity of light will fall. For this reason, it is that the chief ray of the axial outdoor daylight by the side of a liquid crystal panel is parallel (tele cent rucksack nature) to a lens optical axis as a projection lens.

(D) Even if it is a wide angle lens, a circumference illuminance ratio is securable enough.

The projection lens used for this invention equipment fills the above-mentioned demand, and has sufficient resolution, and uses it as the zoom lens to which a projection scale factor is minutely changed and is further made as for moire relief of a projection image, and screen size fine adjustment.

[0033] Hereafter, such a projection lens is explained, referring to a drawing. Drawing 1 to drawing 26 is a lens cross section corresponding to a typical configuration among the gestalten of numerical operation mentioned later. Although not indicated in drawing, a screen shall be above drawing 1 , drawing 3 , drawing 4 , drawing 6 , drawing 8 , drawing 10 , drawing 12 , drawing 14 , drawing 16 , drawing 18 , drawing 19 , drawing 20 , drawing 21 , drawing 23 , drawing 24 , the left of drawing 25 and drawing 2 , drawing 5 , drawing 7 , drawing 9 , drawing 11 , drawing 13 , drawing 15 , drawing 17 , drawing 22 , and drawing 26 . They are the 1st lens group which G1 is located in a screen side (big conjugation side), and has negative refractive power, the 2nd lens group in which G2 has positive refractive power, and the 3rd lens group which G3 is located in a liquid crystal panel 3 side (small conjugation side), and has positive refractive power. The 2nd lens group G2 is near the liquid crystal panel 3 side, and is extracted near the screen side focus of 3rd lens group G3, and has AST. Moreover, between 3rd lens group G3 and a liquid crystal panel 3, the parallel plate L9 (drawing 18 L9 and L10) which has the optical thickness which set the dichroic prism 15 in drawing 61 or drawing 62 which shows the conventional example, and the cover glass (not shown) of a liquid crystal panel 3 is formed.

[0034] In addition, drawing 1 and drawing 2 are the gestalten 1 of operation, and drawing 2 shows the condition of having inserted the bending mirror M of 45 degrees of inclinations in the same lens system as drawing 1 . drawing 3 -- the gestalt 2 of operation, drawing 4 , and drawing 5 -- the gestalt 3 of operation, drawing 6 , and drawing 7 -- the gestalt 4 of operation, drawing 8 , and drawing 9 -- the gestalt 5 of operation, drawing 10 , and drawing 11 -- the gestalt 6 of operation, drawing 12 , and drawing 13 -- the gestalt 7 of operation, drawing 14 , and drawing 15 -- the gestalt 8 of operation, drawing 16 , and drawing 17 -- the gestalten 9-12 of operation, and 14-20 -- For the gestalt 13 of operation, and drawing 19 , the gestalten 21 and 22 of operation and drawing 20 are [drawing 18 / the gestalt 24 of operation, drawing 23 · drawing 26 of the gestalt 23 of operation, drawing 21 , and drawing 22] each lens cross section of the gestalt 25 of operation.

[0035] <The configuration of a lens group> (gestalt 8 of the gestalt 1 of operation · operation) (refer to drawing 1 , drawing 3 , drawing 4 , drawing 6 , drawing 8 , drawing 10 , drawing 12 , and drawing 14) : the 1st lens group G1 The big conjugation side is constituted with positive refractive power by the 1st

convex lens L1, the 2nd lens L2 to which the concave surface strong against a small conjugation side was turned with negative refractive power, and the 3rd lens L3 to which the concave surface strong against a small conjugation side was turned with negative refractive power. The 2nd lens group G2 is constituted by the 4th lens L4 with positive refractive power, it is a small conjugation close-attendants side, and it extracts near the focus by the side of big conjugation of 3rd lens group G3, and AST is prepared. 3rd lens group G3 is constituted by the 5th lens L5 which has negative refractive power and has a concave surface in a small conjugation side, 6th lens L6 by which the big conjugation side was joined to the 5th lens L5 in the convex with positive refractive power, and the 7th and 8th lens L7 and L8 with positive refractive power.

[0036] : (Gestalt 20 of the gestalt 9 of operation - operation) The configuration of the 1st lens group G1 and the 2nd lens group G2 is the same as that of the gestalt 8 of the gestalt 1 of operation - operation (refer to drawing 16 and drawing 18). The 5th lens L5 which 3rd lens group G3 has negative refractive power, and has a concave surface in a small conjugation side, It is constituted by 6th lens L6 by which the big conjugation side was joined to the 5th lens L5 in the convex with positive refractive power, the 7th lens L7 with positive refractive power, and the 8th lens L8 of the aspheric surface which the refractive power for a core is small and has negative refractive power with a strong circumference portion.

[0037] : (The gestalt 21 of operation, gestalt 22 of operation) To the configuration of the gestalt 20 of the gestalt 1 of operation - operation, the configuration of the 1st lens group G1 has the weak refractive power for a core, and has added the aspheric lens L0 which has positive refractive power with a strong circumference portion to the big conjugation side (refer to drawing 19). The configuration of the 2nd lens group G2 is the same as that of the gestalt 20 of the gestalt 1 of operation - operation. 3rd lens group G3 consists of the 5th and 6th same lens L5 as the gestalt 20 of the gestalt 1 of operation - operation, and L6 and the spherical lenses L7 and L8 with positive refractive power.

[0038] : (Gestalt 23 of operation) Although the configuration of the 1st lens group G1 is the same as that of the gestalt 20 of the gestalt 1 of operation - operation, the 3rd lens L3 is an aspheric lens (refer to drawing 20). Although the configuration of the 2nd lens group G2 is the same as that of the gestalt 20 of the gestalt 1 of operation - operation, the 4th lens L4 is an aspheric lens. The configuration of 3rd lens group G3 is the same as that of the gestalten 21 and 22 of operation.

[0039] : (Gestalt 24 of operation) The configuration of the 1st lens group G1 and the 2nd lens group G2 is the same as that of the gestalt 20 of the gestalt 1 of operation - operation (refer to drawing 21). Moreover, the configuration of 3rd lens group G3 is the same as that of the gestalten 21 and 22 of operation.

[0040] : (Gestalt 25 of operation) The configuration of the 1st the 3rd lens group G1 - G3 is the same as that of the gestalt 20 of the gestalt 1 of operation - operation (refer to drawing 23 - drawing 25). However, with the gestalt of this operation, it is the zoom lens which carries out very small change of the projection scale factor. For this reason, the 4th lens L4 of the 2nd lens group G2 is moved in the direction of an optical axis, the focal distance of all lens systems is made adjustable, and migration of the image surface produced by this is compensated by migration of the direction of an optical axis of the 1st the 3rd lens group G1 - G3.

[0041] Both the gestalten of each operation are considered as a retro focus configuration combining the 1st lens group G1 with negative refractive power, the 2nd lens group G2 with positive refractive power, and 3rd lens group G3 as above. The big back focus which can insert the thick parallel plate L9 (it is L9 and L10 at the gestalt 13 of operation shown in drawing 18) after 3rd lens group G3, and can take an air

gap suitable before and after the parallel plate L9 (it is L9 and L10 at the gestalt 13 of operation shown in drawing 18) is secured. Moreover, drawing AST is arranged near the focus by the side of the screen of 3rd lens group G3 (big conjugation side), and is considered as the tele cent rucksack configuration which maintains the chief ray outside a shaft at abbreviation parallel by the liquid crystal panel 3 side (small conjugation side) at an optical axis. Moreover, between the 1st lens group G1 and the 2nd lens group G2, a big air gap is secured and insertion of the bending mirror M is enabled.

[0042] In order to attain specification [of the projection lens mentioned above] (A) - (D), this lens system has satisfied the following conditional expression, when setting the focal distance of the 1st, 2nd, and 3rd lens groups G1 and G2, G3, and all lens systems to f1, f2, f3, and f and setting the air gap of the 1st lens group G1 and the 2nd lens group G2 to D1.

$1.8<D1/f<3.0$ (1)

$1.1<f2/f3<1.6$ (2)

$1.5<|f1|/f<2.3$ (3)

[0043] The semantics of the upper limit of the above-mentioned conditional expression and a lower limit is explained below. first -- the -- one -- a group -- a lens -- a group -- G -- one -- the -- two -- a lens -- a group -- G -- two -- between -- distance -- D -- one -- all -- a lens system -- a focal distance -- a ratio -- setting -- (-- one --) -- a formula -- setting -- (-- one --) -- a formula -- a upper limit -- exceeding -- if -- a mirror -- M -- insertion -- **** -- being advantageous -- although -- the outer diameter of the 1st lens group G1 -- large -- becoming -- and a lens overall length -- unnecessary -- large -- becoming . Conversely, if the lower limit of (1) type is exceeded, in order for insertion of Mirror M to become difficult and to fill a need field angle, the negative power of the 1st lens group G1 becomes strong, and amendment of the aberration outside a shaft becomes difficult.

[0044] Since the positive refractive-power assignment of 3rd lens group G3 will become strong too much compared with the 2nd lens group G2 in the conditions of (2) types which define the ratio of the focal distance of the 2nd lens group G2 and 3rd lens group G3 if the upper limit of (2) types is exceeded, The distortion aberration in the outside of the shaft which is a small conjugation side, is a small conjugation side when it is going to use the chief ray outside a shaft as an optical axis at abbreviation parallel, and was seen occurs greatly in a slack type, and the amendment becomes difficult. Conversely, since the positive refractive-power assignment of 3rd lens group G3 will become weak too much compared with the 2nd lens group G2 if the lower limit of (2) types is exceeded, it becomes difficult for the configuration of a retro focus mold to become weak and to keep a back focus long.

[0045] Subsequently, (3) types have defined the ratio of a focal distance to all the lens systems of the 1st lens group G1. (3) If the upper limit of a formula is exceeded, it will become difficult for the negative refractive-power assignment of the 1st lens group G1 to keep a back focus long, since the configuration of past [weakness] and a retro focus mold becomes weak. Moreover, since a lens overall length increases since it is necessary to take superfluously a large distance between the 1st lens group G1 and the 2nd lens group G2 in order to maintain the refractive power of the 1st lens group G1 in the condition of exceeding the upper limit of (3) types and to secure a long back focus, and the lens outer diameter of the 1st lens group G1 becomes large in connection with it, it is not desirable. On the contrary, if the lower limit of (3) types is exceeded, the negative refractive power of the 1st lens group G1 becomes strong too much, big astigmatism will occur out of a shaft and the amendment will become difficult.

[0046] Next, a numerical example is shown. The semantics of the mark indicated to the table 1 thru/or

table 25 showing the gestalt of numerical operation is as follows. In addition, a focal distance and a scale factor are the values in e line (546.1nm).

f: The focal distance theta of the projection lens whole system : projection half field angle (big conjugation side)

F: The effective F value in a criteria projection scale factor (small conjugation side)

beta: The focal distance f4 of focal-distance f3:lens [3rd] group G3 of the focal-distance f2:lens [2nd] group G2 of the criteria projection scale-factor f1:lens [1st] group G1: The focal distance of an aspheric lens L8 (20 gestalt 9- of operation 25)

f5: The focal distance of an aspheric lens L0 (gestalten 21 and 22 of operation)

D1: The air gap m of the lens [1st] group G1 and the lens [2nd] group G2: The field number counted one by one from the screen side

ri: A refractive index [in / it counts from a screen side, counts from the i-th radius-of-curvature di:screen side of a lens side, counts from an i-th thickness / of a lens component / and air gap ni:screen side, and / the wavelength of 546.1nm (e line) of the i-th lens component] (tables 1-8: gestalten 1-8 of operation)

ni: A refractive index [in / it counts from a screen side and / the wavelength of 587.6nm (d line) of the i-th lens component] (tables 9-25: gestalten 9-25 of operation)

nui: Count from a screen side and it is the Abbe number AST:drawing side [0047] of the i-th lens component. Moreover, the field configuration of the aspheric surface shown by * in a table 9-25 In the rectangular coordinate system (X, Y, Z) which made the center of a field the zero and set the Z-axis as the direction of an optical axis, when making r into main radius of curvature and making respectively a cone constant, A4, and A6, A8 and A10 into the 4th aspheric surface coefficient [6th / 8th / 10th] for K, it shall be expressed with (following 4) and following (5) type.

[0048]

[Equation 1]

$$Z=\frac{\phi^2/r}{1+[1-(1+K)\phi^2/r^2]^{1/2}}+\sum_{i=2}^{5}A_{2i}\phi^{2i} \quad (4)$$

$$\phi=\sqrt{X^2+Y^2} \quad (5)$$

[0049] <Gestalt 1 of operation> drawing 1 shows the gestalt 1 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 1. Drawing 2 is the example which inserted the bending mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 1 , and let the beam of light pass. In drawing 2 , distance of the 1st lens group last side center (C1) and the center (C2) of Mirror M was set to 44.06mm. Moreover, drawing AST was close to the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group G2, and is arranged. Drawing 2 shows that sufficient gap for insertion of Mirror M is securable between the 1st lens group G1 and the 2nd lens group G2. The circumference illuminance ratio obtained 84.6% in the maximum half field angle (41.60 degrees) according to the effect of the pupil aberration besides a shaft. general -- a projection mold display -- a circumference illuminance ratio -- although 30% is needed, compared with this, it is a sufficiently good value. Moreover, the chief ray angle besides a shaft was 0.3 degrees or less. Moreover, drawing 2 shows that an inclination [as opposed to the optical axis of axial outdoor daylight from a screen side (big conjugation side)] becomes small inside a lens system. For this reason, Mirror M is made smaller than

the case where it arranges out of a projection lens (screen side).

[0050]

[A table 1]

実施の形態 1

f=24.00　θ=41.60°　F=4.5　β=23.5

f1=-41.35　f2=78.82　f3=64.78　D1=65.61

D1/f=2.73　f2/f3=1.22　| f1 | /f=1.72

m	r i	d i	n i	ν i
1	139.17585	8.90	1.69980	55.5
2	1401.53292	0.10		
3	132.10005	3.00	1.61686	37.0
4	32.25716	10.94		
5	164.89057	3.00	1.64129	55.5
6	35.81876	65.61		
7	134.01990	4.10	1.81264	25.5
8	-120.99001	47.31		
9	-104.18790	2.57	1.81264	25.5
10	40.63287	13.71	1.73234	54.7
11	-70.25245	0.10		
12	172.28250	4.96	1.69980	55.5
13	-275.26863	0.10		
14	75.80423	7.84	1.69980	55.5
15	219.60430	5.00		
16	INF	51.00	1.51872	64.2
17	INF			

AS'

[0051] <Gestalt 2 of operation> drawing 3 shows the gestalt 2 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 2. With the gestalt of this operation, it is 68.93mm, and the gap d6 (= D1) of the 1st lens group G1 and the 2nd lens group G2 has secured the gap large 3.32mm, and is more satisfactory than the gestalt 1 of operation to insertion of Mirror M.

[0052]

[A table 2]

実施の形態2

f=24.00　θ=41.56°　P=4.5　β=23.5
f1=-42.27　f2=79.73　f3=66.10　D1=68.93
D1/f=2.87　f2/f3=1.21　|f1|/f=1.76

m	r i	d i	n i	ν i
1	138.07949	8.90	1.69980	55.5
2	1129.63736	0.10		
3	117.39695	2.01	1.61686	37.0
4	32.01591	11.58		
5	165.64017	2.01	1.64129	55.5
6	36.48719	68.93		
7	145.52849	4.10	1.81264	25.5
8	-115.30880	48.14		
9	-101.53291	2.57	1.81264	25.5
10	41.07525	13.71	1.73234	54.7
11	-70.47261	0.10		
12	142.18918	4.96	1.69980	55.5
13	-440.96858	0.10		
14	79.84551	7.84	1.69980	55.5
15	259.57190	5.00		
16	INF	51.00	1.51872	64.2
17	INF			

AST

[0053] <Gestalt 3 of operation> drawing 4 shows the gestalt 3 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 3. With the gestalt of this operation, the gap d6 (= D1) of the 1st lens group G1 and the 2nd lens group G2 is 53.83mm, and is a gap small 11.78mm from the gestalt 1 of operation. Drawing 5 is the example which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 4 , and let the beam of light pass. In drawing 5 , distance from the last side center (C1) of the 1st lens group G1 to the center (C2) of Mirror M was set to 34.6mm. Moreover, drawing AST is the lens L4 which constitutes the 2nd lens group G2. It was close to the field by the side of small conjugation, and arranges. Drawing 5 shows that Mirror M can be enough inserted between the 1st lens group G1 and the 2nd lens group G2.

[0054]

[A table 3]

実施の形態3

f=25.01　θ=40.64°　P=4.5　β=23.5
f1=-39.74　f2=73.44　f3=61.20　D1=53.83
D1/f=2.15　f2/f3=1.20　|f1|/f=1.59

m	r i	d i	n i	ν i
1	146.47790	8.90	1.69980	55.5
2	-9528.73000	0.10		
3	166.98639	3.00	1.61686	37.0
4	29.32481	6.68		
5	77.99256	3.00	1.64129	55.5
6	30.44297	53.83		
7	442.15849	4.10	1.81264	25.5
8	-68.70715	45.61		
9	-101.08267	2.57	1.81264	25.5
10	40.44856	13.71	1.73234	54.7
11	-61.07050	0.10		
12	409.67064	4.96	1.69980	55.5
13	-163.35741	0.10		
14	95.94786	7.84	1.69980	55.5
15	688.57440	5.00		
16	INF	51.00	1.51872	64.2
17	INF			

AST

[0055] <Gestalt 4 of operation> drawing 6 shows the gestalt 4 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 4. With the gestalt of this operation, the gap d6 (= D1) of the 1st lens group G1 and the 2nd lens group G2 is 47.65mm, and is a gap small 17.96mm from the gestalt 1 of operation. Drawing 7 is the example which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 6 , and let the beam of light pass. It sets to drawing 7 and is the 1st lens group G1. Distance from the last side center (C1) to the center (C2) of Mirror M was set to 28.5mm. Moreover, drawing AST was close to the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group G2, and is arranged. Drawing 7 shows that Mirror M can be mounted in a compact between the 1st lens group G1 and the 2nd lens group G2.

[0056]

[A table 4]

実施の形態 4

f=23.83 θ=41.94° F=4.5 β=23.5
f1=-38.88 f2=74.83 f3=60.55 D1=47.65
D1/f=2.00 f2/f3=1.24 | f1 | /f=1.63

m	r i	d i	n i	ν i	
1	142.84549	8.90	1.69980	55.5	
2	2664.39249	0.10			
3	142.87467	3.00	1.61686	37.0	
4	30.66992	7.58			
5	92.27039	3.00	1.64129	55.5	
6	29.69118	47.65			
7	555.51124	21.91	1.81264	25.5	
8	-67.07983	44.63			AST
9	-100.21012	2.57	1.81264	25.5	
10	42.13455	13.71	1.73234	54.7	
11	-63.35782	0.10			
12	410.78378	4.96	1.69980	55.5	
13	-132.22409	0.10			
14	118.11951	7.84	1.69980	55.5	
15	INF	5.00			
16	INF	51.00	1.51872	64.2	
17	INF				

[0057] <Gestalt 5 of operation> drawing 8 shows the gestalt 5 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 5. Drawing 9 is the example which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 8 , and let the beam of light pass. In drawing 9 , distance of the 1st lens group last side center (C1) and the center (C2) of Mirror M was set to 37.00mm. Moreover, drawing AST is arranged 1mm behind the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group G2 (the 9th page of a table 5). Drawing 9 shows that sufficient gap for insertion of Mirror M is securable between the 1st lens group G1 and the 2nd lens group G2. The circumference illuminance ratio obtained 81% in the maximum half field angle (43.30 degrees) according to the effect of the pupil aberration besides a shaft. general -- a projection mold display -- a circumference illuminance ratio -- although 30% is needed, compared with this, it is a sufficiently good value. Moreover, the chief ray inclination besides a shaft was 0.6 degrees or less. Moreover, drawing 9 shows that the inclination to the optical axis of axial outdoor daylight becomes small rather than the flux of light which carries out outgoing radiation to a screen side (big conjugation side) inside a lens system. For this reason, Mirror M is made smaller than the case where it arranges out of a projection lens

(screen side).

[0058]

[A table 5]

実施の形態5

f=24.00　θ=43.30°　F=4.5　β=23.5

f1=-42.27　f2=73.40　f3=58.09　D1=55.45

D1/f=2.31　f2/f3=1.26　|f1|/f=1.76

m	r i	d i	n i	ν i	
1	134.00000	12.00	1.69980	55.5	
2	852.40000	0.20			
3	130.40000	3.00	1.61686	37.0	
4	33.75800	11.25			
5	122.00000	3.00	1.64129	55.5	
6	32.15000	55.45			
7	148.00000	10.00	1.81264	25.5	
8	-96.89200	1.00			
9	INF	35.85			AST
10	-73.90000	3.00	1.81264	25.5	
11	39.40000	18.00	1.73234	54.7	
12	-62.25000	0.20			
13	297.80000	6.05	1.69980	55.5	
14	-165.07000	0.20			
15	87.20200	7.60	1.69980	55.5	
16	INF	5.00			
17	INF	51.00	1.51872	64.2	
18	INF				

[0059] <Gestalt 6 of operation> drawing 10 shows the gestalt 6 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 6. Drawing 11 is the example which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 10 , and let the beam of light pass. In drawing 11 , distance of the 1st lens group last side center (C1) and the center (C2) of Mirror M was set to 37.00mm. Moreover, drawing AST is arranged 1mm behind the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group G2 (the 9th page of a table 6). Drawing 11

shows that sufficient gap for insertion of Mirror M is securable between the 1st lens group G1 and the 2nd lens group G2.

[0060]

[A table 6]

実施の形態 6

f=24.00 θ=43.15° F=4.5 β=23.5
f1=-42.38 f2=73.60 f3=58.04 D1=55.49
D1/f=2.31 f2/f3=1.27 | f1 | /f=1.77

m	r i	d i	n i	ν i	
1	133.71183	12.00	1.69980	55.5	
2	897.73287	0.20			
3	131.74787	3.00	1.61686	37.0	
4	33.61126	11.25			
5	121.13110	3.00	1.64129	55.5	
6	32.31767	55.49			
7	148.79356	10.00	1.81264	25.5	
8	-96.99648	1.00			
9	INF	35.81			AST
10	-73.31168	3.03	1.81264	25.5	
11	39.37385	18.00	1.73234	54.7	
12	-61.28330	0.20			
13	297.62443	6.07	1.69980	55.5	
14	-170.03076	0.20			
15	87.18402	7.64	1.69980	55.5	
16	INF	5.00			
17	INF	51.00	1.51872	64.2	
18	INF				

[0061] <Gestalt 7 of operation> drawing 12 shows the gestalt 7 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 7. With the gestalt of this operation, the gap d6 (= D1) of the 1st lens group G1 and the 2nd lens group G2 is 50.44mm, and is a gap small 5.01mm from the gestalt 5 of operation. Drawing 13 is the example which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 12 , and let the beam of light pass. drawing -- setting -- the 1st lens group G1 Distance from the last side center (C1) to the center (C2) of Mirror M was set to 32.0mm. Moreover, drawing AST was close to the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group G2, and is arranged (the 9th page of a table 7). Drawing 13 shows that Mirror M can be enough inserted between the 1st lens group G1 and the 2nd lens group G2.

[0062]

[A table 7]

実施の形態7

f=24.00　θ=43.28°　F=4.5　β=23.5

f1=-38.93　f2=71.91　f3=61.38　D1=50.44

D1/f=2.10　f2/f3=1.17　|f1|/f=1.62

m	r i	d i	n i	ν i	
1	136.53513	12.00	1.69980	55.5	
2	980.12571	0.09			
3	129.33447	3.00	1.61686	37.0	
4	31.19552	9.79			
5	94.73813	3.00	1.64129	55.5	
6	29.10866	50.44			
7	671.82960	16.86	1.81264	25.5	
8	-63.28762	0.00			
9	INF	41.47			AST
10	-100.80370	3.03	1.81264	25.5	
11	40.30690	18.00	1.73234	54.7	
12	-63.45385	0.10			
13	705.07045	6.07	1.69980	55.5	
14	-133.81413	0.10			
15	117.24205	7.64	1.69980	55.5	
16	INF	5.00			
17	INF	51.00	1.51872	64.2	
18	INF				

[0063] <Gestalt 8 of operation> drawing 14 shows the gestalt 8 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 8. With the gestalt of this operation, the gap d6 (= D1) of the 1st lens group G1 and the 2nd lens group G2 is 45.13mm, and is a gap small 10.32mm from the gestalt 5 of operation. Drawing 15 is the example which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 14 , and let the beam of light pass. In drawing, distance from the last side center (C1) of the 1st lens group G1 to the center (C2) of Mirror M was set to 28.0mm. Moreover, drawing AST was close to the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group, and is arranged (the 9th page of a table 8). Drawing 15 shows that Mirror M can be mounted in a compact between the 1st lens group G1 and the 2nd lens group G2.

[0064]

[A table 8]

実施の形態 8

f=24.00 θ=43.29° F=4.5 β=23.5
f1=-38.98 f2=72.76 f3=61.57 D1=45.13
D1/f=1.88 f2/f3=1.18 | f1 | /f=1.62

m	r i	d i	n i	ν i	
1	135.58642	12.00	1.69980	55.5	
2	874.87953	0.09			
3	126.33461	2.84	1.61686	37.0	
4	30.51499	10.38			
5	98.05461	2.84	1.64129	55.5	
6	30.15873	45.13			
7	723.13709	27.18	1.81264	25.5	
8	-63.30892	0.00			
9	INF	41.97			AST
10	-109.36421	3.03	1.81264	25.5	
11	40.89621	18.00	1.73234	54.7	
12	-66.03057	0.10			
13	569.43909	6.07	1.69980	55.5	
14	-131.03458	0.10			
15	124.74636	7.64	1.69980	55.5	
16	INF	5.00			
17	INF	51.00	1.51872	64.2	
18	INF				

[0065] <Gestalt 9 of operation> drawing 16 shows the gestalt 9 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 9. Drawing 17 is the example which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 16 , and let the beam of light pass. In drawing 17 , distance of the 1st lens group last side center (C1) and the center (C2) of Mirror M was set to 60.0mm. Moreover, drawing AST is arranged 3.3mm behind the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group (the 9th page of a table 9). Drawing 17 shows that sufficient gap for insertion of Mirror M is securable between the 1st lens group G1 and the 2nd lens group G2. The chief ray inclination besides a shaft is 1 degree or less, and good tele cent rucksack nature is obtained. Moreover, drawing 17 shows that the inclination to the optical axis of axial outdoor daylight becomes small rather than the flux of light which carries out outgoing radiation to a screen side (big conjugation side) inside a lens system (between G1 - G2). For this reason, Mirror M is made smaller than the case where it arranges out of a projection lens (screen side). As for the circumference illuminance ratio, 55% or more is obtained with the maximum half field angle according to the effect of the pupil aberration besides a shaft. general -- a projection mold display -- a circumference illuminance ratio -- it is a sufficiently good value that 30% is needed compared with this. Furthermore, the aspheric lens L8 has negative power with the big circumference with main small power, and amendment with the negative distortion aberration of the periphery seen by the liquid crystal panel 3 side and high order astigmatism is performed with sufficient balance.

[0066] In addition, it is desirable for the ratio of the focal distance f4 of L8 and the focal distance f of all lens systems to fill the relation of (6) types with the configuration which uses the last lens L8 of 3rd lens group G3 as an aspheric lens including the gestalten 10-20 of operation mentioned later and the gestalt 25 of operation.

| f4 | /f>10 (6)

(6) If the lower limit of a formula is exceeded, the shaft top refractive power of an aspheric lens L8 will become strong too much. When L8 is created with plastic material for this reason, it becomes impossible

to disregard the problem of focal gap of the projection image by environmental variations, such as temperature and humidity.

[0067]

[A table 9]

実施の形態 9

f=41.02 θ=43.35° F=4.5 β=14.5
f1=-83.85 f2=118.52 f3=88.30 D1=95.00
D1/f=2.32 f2/f3=1.34 | f1 | /f=2.04
f4=-1718.07 | f4 | /f=41.88

m	r i	d i	n l	ν i	
1	209.28882	18.00	1.69680	55.5	
2	740.90423	0.20			
3	190.31778	5.00	1.61293	37.0	
4	59.32194	21.02			
5	338.42940	4.00	1.63854	55.4	
6	69.63940	95.00			
7	320.89460	14.00	1.69894	30.1	
8	-110.81612	3.30			
9	INF	55.46			AST
10	-60.17964	10.83	1.84666	23.8	
11	162.62940	26.00	1.69680	55.5	
12	-59.95669	0.20			
13	126.56120	28.00	1.62299	58.1	
14	-141.09431	0.20			
15	-515.53888	3.00	1.49154	57.8	*
16	-1317.55068	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

<非球面係数>

m	K	A 4	A 6	A 8	A 1 0
15	101.211102	0.2532218-7	0.666013E-10	0.925652E-14	0.720830E-17
16	-2000.000000	0.389066E-6	0.457664E-10	0.361257E-13	0.444744E-17

[0068] The numeric data of the gestalten 10-12 of the <gestalten 10-12 of operation> operation is shown in tables 10-12. The lens cross section of the gestalt of each operation is almost equivalent to drawing 16 which shows the gestalt 9 of operation. Also with the gestalt of each [these] operation, the air gap comparable as the gestalt 9 of operation can be secured between the 1st lens group G1 and the 2nd lens group G2, and it is satisfactory to insertion of Mirror M.

[0069]

[A table 10]

実施の形態１０

f=41.01　θ=43.25°　F=4.5　β=14.5
f1=-78.55　f2=116.78　f3=92.35　D1=95.00
D1/f=2.32　f2/f3=1.26　|f1|/f=1.92
f4=-1846.54　|f4|/f=45.03

m	ri	di	ni	νi	
1	214.09482	18.00	1.69680	55.5	
2	910.92980	0.10			
3	193.62553	5.00	1.61293	37.0	
4	56.62424	21.52			
5	358.74711	4.00	1.63854	55.4	
6	68.54356	95.00			
7	275.62302	14.00	1.69894	30.1	
8	-114.80012	3.31			
9	INF	60.70			AST
10	-56.84164	4.34	1.84666	23.8	
11	191.34903	26.00	1.69680	55.5	
12	-57.44741	0.10			
13	122.68404	23.00	1.62299	58.1	
14	-141.10233	0.10			
15	-509.36767	3.00	1.49154	57.8	*
16	-1156.99893	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

＜非球面係数＞

m	K	A4	A6	A8	A10
15	102.52516	0.343121E-7	0.765024E-10	0.105031E-13	0.924494E-17
16	-2000.000000	0.405307E-6	0.541539E-10	0.452024E-13	0.534341E-17

[0070]

[A table 11]

実施の形態１１

f=41.02　θ=43.31°　F=4.5　β=14.5
f1=-80.97　f2=117.92　f3=90.62　D1=95.00
D1/f=2.32　f2/f3=1.30　|f1|/f=1.97
f4=-1836.13　|f4|/f=44.76

m	ri	di	ni	νi	
1	207.13526	18.00	1.69680	55.5	
2	758.25591	0.10			
3	185.17029	5.00	1.61293	37.0	
4	58.14060	22.16			
5	469.20601	4.00	1.63854	55.4	
6	71.34215	95.00			
7	278.16884	14.00	1.69894	30.1	
8	-115.96523	3.31			
9	INF	58.35			AST
10	-57.07889	5.68	1.84666	23.8	
11	186.26313	26.16	1.69680	55.5	
12	-57.43884	0.10			
13	123.85803	23.00	1.62299	58.1	
14	-141.04934	0.10			
15	-508.72473	3.00	1.49154	57.8	*
16	-1162.01899	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

＜非球面係数＞

m	K	A4	A6	A8	A10
15	102.60548	0.326666E-7	0.760660E-10	0.105266E-13	0.918507E-17
16	-2000.000000	0.408050E-6	0.535449E-10	0.445331E-13	0.517802E-17

[0071]

[A table 12]

実施の形態１２

f=41.01　θ=48.25°　P=4.5　β=14.5
f1=-77.81　f2=116.41　f3=92.57　D1=95.00
D1/f=2.32　f2/f3=1.26　|f1|/f=1.90
f4=-1987.38　|f4|/f=48.46

m	r i	d i	n i	ν i	
1	218.48840	17.00	1.69680	55.5	
2	1028.03053	0.10			
3	196.04580	5.00	1.61293	37.0	
4	57.99843	21.50			
5	425.30204	4.00	1.63854	55.4	
6	68.23706	95.00			
7	240.48781	14.00	1.69894	30.1	
8	-121.43348	3.31			
9	INF	60.91			AST
10	-56.74421	3.91	1.84666	23.8	
11	182.38945	26.00	1.69680	55.5	
12	-57.85630	0.10			
13	120.39684	23.00	1.62299	58.1	
14	-141.16501	0.10			
15	-510.31629	3.00	1.49154	57.8	*
16	-1065.78653	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

<非球面係数>

m	K	A 4	A 6	A 8	A 1 0
15	102.380758	0.349514E-7	0.7607668-10	0.102687E-13	0.926386E-17
16	-2000.000000	0.403383E-6	0.559040E-10	0.461159E-13	0.554591E-17

[0072] <Gestalt 13 of operation> drawing 18 is the lens cross section of the gestalt 13 of operation. Moreover, numeric data is shown in a table 13. Also with the gestalt of this operation, the air gap comparable as the gestalt 9 of operation can be secured between the 1st lens group G1 and the 2nd lens group G2, and insertion of Mirror M is possible. Moreover, the gestalt of this operation is performing aberration amendment, where PMMA resin L9 with a thickness of 70mm and the glass plate L10 (BSC7:Hoya Corp. make) with a thickness of 1mm are inserted as a parallel plate after 3rd lens group G3. This assumes creating the dichroic prism for color composition using PMMA resin so that it may mention later in relation to the 3rd invention. Moreover, the glass plate of 1mm thickness assumes the glass substrate for liquid crystal enclosure of a liquid crystal panel.

[0073] Even if it plastics-izes a dichroic prism like the gestalt of this operation, aberration amendment is possible good, and low-pricing of a projection mold display and lightweight-ization can be realized. In addition, since the parallel plate L9 of a dichroic prism does not have refractive power, even if the refractive index of plastic material changes with environmental variations, such as temperature and humidity, there is no big effect in a focal gap of a projection image. Moreover, PC, ZEONEX (Nippon Zeon Co., Ltd. make), OZ1000(Hitachi Chemical Co., Ltd. make) ARTON (Japan Synthetic Rubber Co., Ltd. make), APO (Mitsui Petrochemical Industries, Ltd. make), etc. are usable as plastic material other than PMMA. Moreover, with the gestalt of this operation, although referred to as 70mm, the thickness of the plastics parallel plate L9 can be adjusted according to the screen size of a liquid crystal panel 3 so that more clearly than drawing 61 and drawing 62 which show the conventional projection mold display. Therefore, aberration amendment is possible even for the size (for example, about 15-70mm) of 70mm or less enough by the configuration equivalent to this lens system. Moreover, even if the thickness of L9 exceeds 70mm, as long as there is no trouble in arrangement of a liquid crystal panel 3, aberration amendment is possible similarly. That is, even if it plastics-izes 90% or more of overall thickness Mino of a parallel plate, aberration amendment is fully possible.

[0074]

[A table 13]

実施の形態13

f=41.00 θ=48.34° F=4.5 β=14.5
f1=-84.12 f2=119.57 f3=88.28 D1=95.00
D1/f=2.32 f2/f3=1.35 |f1|/f=2.05
f4=-1708.02 |f4|/f=41.54

m	ri	di	ni	νi	
1	208.10985	18.00	1.69680	55.5	
2	760.71289	0.20			
3	193.50540	5.00	1.61293	37.0	
4	59.27095	21.03			
5	342.67312	4.00	1.69854	55.4	
6	70.22761	95.00			
7	334.13001	14.00	1.69894	30.1	
8	-110.65841	8.30			
9	INF	54.88			AST
10	-61.04168	11.64	1.84666	23.8	
11	158.39334	26.00	1.69380	55.5	
12	-60.48160	0.20			
13	128.04196	23.00	1.62299	58.1	
14	-141.07358	0.20			
15	-517.11586	3.00	1.49154	57.8	※
16	-1346.4762	20.00			※
17	INF	70.00	1.49154	57.8	
18	INF	1.00	1.51680	64.2	
19	INF				

<非球面係数>

m	K	A4	A6	A8	A10
15	100.776415	0.283045E-7	0.646495E-10	0.9121318-14	0.6864038-17
16	-2000.000000	0.3802308-6	0.447852E-10	0.3445268-13	0.432562E-17

[0075] The numeric data of the gestalten 14-20 of the <gestalten 14-20 of operation> operation is shown in tables 14-20. Since the lens cross section of the gestalt of each operation is similar with drawing 16 which shows the gestalt 9 of operation, it omits a graphic display. Also with the gestalt of each [these] operation, the air gap comparable as the gestalt 9 of operation can be secured to the 1st lens group and the 2nd lens between groups, and it is satisfactory to insertion of Mirror M.

[0076]

[A table 14]

実施の形態１４

f=41.02　θ=43.41°　P=4.5　β=14.5
f1=-80.79　f2=131.75　f3=90.42　D1=93.00
D1/f=2.27　f2/f3=1.46　|f1|/f=1.97
f4=-813.27　|f4|/f=19.83

m	r i	d i	n i	ν i	
1	247.63993	17.00	1.69680	55.5	
2	869.53816	0.10			
3	180.49687	5.00	1.61293	37.0	
4	59.15650	21.82			
5	394.02309	4.00	1.63854	55.4	
6	71.68554	93.00			
7	779.91992	14.00	1.80518	25.5	
8	-123.10690	11.71			
9	INF	62.12			AST
10	-61.94791	2.80	1.80518	25.5	
11	132.49952	25.50	1.71300	53.9	
12	-60.68283	0.10			
13	128.02330	24.23	1.67790	55.5	
14	-144.33425	0.12			
15	-545.16245	3.58	1.49154	57.8	*
16	1525.448159	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

＜非球面係数＞

m	K	A 4	A 6	A 8	A 1 0
15	102.000000	-0.135920E-6	0.544483E-10	0.511768E-14	0.424992E-17
16	-2000.000000	0.395527E-6	0.129353E-10	0.257261E-13	0.592184E-17

[0077]

[A table 15]

実施の形態１５

f=41.00　θ=43.46°　P=4.5　β=14.5
f1=-85.37　f2=139.19　f3=88.93　D1=95.00
D1/f=2.32　f2/f3=1.57　|f1|/f=2.08
f4=-1997.50　|f4|/f=48.72

m	r i	d i	n i	ν i	
1	229.60991	18.00	1.69680	55.5	
2	815.85357	0.20			
3	218.87795	5.00	1.61293	37.0	
4	60.82318	21.82			
5	427.20443	4.00	1.63854	55.4	
6	78.31506	95.00			
7	1842.49361	14.00	1.80518	25.5	
8	-120.09981	12.00			
9	INF	62.60			AST
10	-74.15737	8.00	1.80518	25.5	
11	112.57176	26.00	1.71300	53.9	
12	-63.64452	0.20			
13	173.92879	23.00	1.67790	55.5	
14	-137.91210	0.20			
15	-519.52669	3.00	1.49154	57.8	*
16	-1100.36498	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

＜非球面係数＞

m	K	A 4	A 6	A 8	A 1 0
15	90.479412	-0.943206E-8	0.289802E-10	0.547844E-14	0.566579E-17
16	-2000.000000	0.246880E-6	0.980317E-10	0.206938E-13	0.367889E-17

[0078]

[A table 16]

実施の形態１６

f=41.00　θ=43.35°　P=4.5　β=14.5
f1=-84.86　f2=135.66　f3=87.65　D1=95.00
D1/f=2.32　f2/f3=1.55　|f1|/f=2.07
f4=-1662.67　|f4|/f=40.55

m	ri	di	ni	νi	
1	257.41023	12.84	1.69680	55.5	
2	1130.80334	0.10			
3	179.27669	2.80	1.61293	37.0	
4	61.14283	20.93			
5	318.65098	2.80	1.63854	55.4	
6	70.92954	95.00			
7	615.02360	8.00	1.80518	25.5	
8	-133.53002	14.15			
9	INF	61.07			AST
10	-60.41649	2.80	1.80518	25.5	
11	149.20663	22.88	1.71300	53.9	
12	-58.65602	0.10			
13	128.37404	19.03	1.67790	55.5	
14	-152.80432	0.10			
15	-722.06424	3.00	1.49154	57.8	*
16	-6019.57696	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

＜非球面係数＞

m	K	A4	A6	A8	A10
15	199.700459	-0.963286E-7	0.470225E-10	0.668325E-14	0.736259E-17
16	-1000.000000	0.333081E-6	0.343574E-10	0.293414E-13	0.449826E-17

[0079]

[A table 17]

実施の形態１７

f=41.00　θ=43.30°　P=4.5　β=14.5
f1=-81.76　f2=129.91　f3=89.73　D1=93.00
D1/f=2.27　f2/f3=1.45　|f1|/f=1.99
f4=-829.17　|f4|/f=20.22

m	ri	di	ni	νi	
1	241.86167	17.00	1.69680	55.5	
2	1042.70429	0.20			
3	197.11785	5.00	1.61293	37.0	
4	60.44744	21.03			
5	352.58126	4.00	1.63854	55.4	
6	69.85648	93.00			
7	637.35510	14.00	1.80518	25.5	
8	-125.28619	11.45			
9	INF	59.18			AST
10	-60.25897	3.00	1.80518	25.5	
11	132.82538	25.50	1.71300	53.9	
12	-58.94358	0.20			
13	120.98851	22.00	1.65020	55.7	
14	-145.87655	0.20			
15	-713.93564	3.00	1.52540	56.3	*
16	1131.46191	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

＜非球面係数＞

m	K	A4	A6	A8	A10
15	200.952916	-0.106096E-6	0.589142E-10	0.736031E-14	0.701461E-17
16	404.800069	0.374221E-6	0.190386E-10	0.310185E-13	0.670009E-17

[0080]

[A table 18]

実施の形態１８

f=41.00　θ=43.33°　P=4.5　β=14.5
f1=-82.33　f2=131.31　f3=89.29　D1=93.00
D1/f=2.27　f2/f3=1.47　|f1|/f=2.01
f4=-878.85　|f4|/f=21.44

m	r i	d i	n i	ν i	
1	246.28621	17.00	1.69680	55.5	
2	1088.41351	0.20			
3	206.70541	5.00	1.61293	37.0	
4	61.27672	20.63			
5	324.37105	4.00	1.63854	55.4	
6	69.56946	93.00			
7	718.53096	14.00	1.80518	25.5	
8	-124.22268	12.71			
9	INF	58.98			AST
10	-60.81688	3.00	1.80518	25.5	
11	134.68545	25.50	1.71300	53.9	
12	-58.81675	0.20			
13	128.92691	22.00	1.67790	55.5	
14	-152.22962	0.20			
15	-717.64984	3.21	1.52540	56.3	*
16	1312.42964	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

＜非球面係数＞

m	K	A 4	A 6	A 8	A 1 0
15	200.354009	-0.110832E-6	0.536284E-10	0.656798E-14	0.677723E-17
16	321.788587	0.354296E-6	0.212024E-10	0.291269E-13	0.566620E-17

[0081]

[A table 19]

実施の形態１９

f=41.00　θ=43.33°　P=4.5　β=14.5
f1=-84.69　f2=134.96　f3=88.10　D1=95.00
D1/f=2.32　f2/f3=1.53　|f1|/f=2.06
f4=-1507.90　|f4|/f=36.78

m	r i	d i	n i	ν i	
1	263.71173	13.18	1.69680	55.5	
2	1494.08116	0.10			
3	197.25859	2.80	1.61293	37.0	
4	62.39665	19.93			
5	300.34894	2.80	1.63854	55.4	
6	69.80455	95.00			
7	538.93483	10.26	1.80518	25.5	
8	-136.51341	13.07			
9	INF	61.57			AST
10	-60.56141	2.80	1.80518	25.5	
11	144.95228	22.89	1.71300	53.9	
12	-58.72942	0.10			
13	128.05226	18.96	1.67790	55.5	
14	-152.72486	0.10			
15	-729.88175	3.00	1.52540	56.3	*
16	-8848.89019	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

＜非球面係数＞

m	K	A 4	A 6	A 8	A 1 0
15	198.348669	-0.103625E-6	0.479375E-10	0.565819E-14	0.660449E-17
16	-1000.000000	0.317995E-6	0.242825E-10	0.277963E-13	0.471735E-17

[0082]

[A table 20]

実施の形態２０

f=41.00　θ=43.27°　P=4.5　β=14.5
f1=-81.96　f2=127.70　f3=80.63　D1=97.00
D1/f=2.37　f2/f3=1.41　|f1|/f=2.00
f4=-3297.50　|f4|/f=80.48

m	r i	d i	n i	ν i	
1	217.01481	13.73	1.69680	55.5	
2	823.26087	0.10			
3	155.37376	2.20	1.61293	37.0	
4	57.95555	21.52			
5	318.80893	2.20	1.63854	55.4	
6	65.59215	97.00			
7	635.45623	7.00	1.80518	25.5	
8	-123.42112	5.29			
9	INF	65.49			AST
10	-66.86998	2.20	1.80518	25.5	
11	113.84212	24.08	1.71300	53.9	
12	-60.77809	0.10			
13	142.83715	16.21	1.69680	55.5	
14	-180.08480	0.10			
15	-1125.93847	2.20	1.52540	56.3	*
16	-3193.16731	20.00			*
17	INF	71.00	1.51680	64.2	
18	INF				

<非球面係数>

m	K	A 4	A 6	A 8	A 1 0
15	205.302614	-0.143209E-6	0.436306E-10	0.352016E-14	0.459394E-17
16	2243.146704	0.301114E-6	0.385417E-11	0.212312E-13	0.505731E-17

[0083] <Gestalt 21 of operation> drawing 19 is the lens cross section of the gestalt 21 of operation. The numeric data of the gestalt 21 of operation is shown in a table 21. The sufficiently big air gap can be secured between the 1st lens group G1 and the 2nd lens group G2, and it is satisfactory at all to insertion of Mirror M. With the gestalt of this operation, the 1st lens group G1 was considered as the four-sheet configuration, the refractive power on a shaft is weak in the lens L0 by the side of big conjugation, and the distortion aberration besides a shaft is mainly amended as a double-sided aspheric lens with which a periphery has strong positive refractive power. In addition, as for an aspheric lens L0, it is desirable for the ratios of the focal distance f5 of L0 and the focal distance f of all lens systems including the gestalt 22 of operation mentioned later to fill the relation of (7) types.

|f5|/f>100 (7)

(7) If the lower limit of a formula is exceeded, the shaft top refractive power of an aspheric lens L0 will become strong too much. When creating L0 with plastic material, it becomes impossible for this reason, to disregard the problem of focal gap of the projection image by environmental variations, such as temperature and humidity.

[0084]

[A table 21]

実施の形態２１

f=41.00　θ=42.55°　R=4.5　β=14.5
f1=-72.66　f2=135.07　f3=107.46　D1=104.43
D1/f=2.55　f2/f3=1.26　|f1|/f=1.77
f5=5.8283　f5/f=142

m	ri	di	ni	νi	
1	817.86370	23.95	1.49154	57.8	*
2	1132.05530	0.99			*
3	342.82557	17.00	1.69680	55.5	
4	3105.23658	0.22			
5	4134.01653	6.00	1.61293	37.0	
6	58.61559	16.88			
7	139.01296	5.00	1.63854	55.4	
8	65.35020	104.43			
9	339.98114	30.00	1.80518	25.5	
10	-155.67589	8.11			
11	INF	64.91			AST
12	-135.31259	19.58	1.80518	25.5	
13	77.61582	23.00	1.72916	54.7	
14	-109.27451	0.20			
15	1141.72544	17.28	1.69680	55.5	
16	-229.34545	0.20			
17	197.29088	24.94	1.69680	55.5	
18	17779.90764	20.00			
19	INF	71.00	1.51680	64.2	
20	INF				

<非球面係数>

m	K	A4	A6	A8	A10
1	43.136111	0.108317E-6	-0.282015E-11	-0.240621E-16	0.374139E-20
2	-6.226369	0.660407E-9	-0.118567E-12	-0.386260E-17	0.155721E-20

[0085] The numeric data of the gestalt 22 of the <gestalt 22 of operation> operation is shown in a table 22. The lens cross section of the gestalt of this operation is similar with drawing 19 which shows the gestalt 21 of operation. Also with the gestalt of this operation, the sufficiently big air gap can be secured between the 1st lens group G1 and the 2nd lens group G2, and it is satisfactory to insertion of Mirror M. Moreover, with the gestalt of this operation, the distortion aberration besides a shaft is mainly amended by making only the field by the side of big conjugation of the lens L0 of the 1st lens group into the aspheric surface.

[0086]

[A table 22]

実施の形態２２

f=41.00 θ=42.79° F=4.5 β=14.5
f1=-72.15 f2=133.23 f3=107.69 D1=104.66
D1/f=2.55 f2/f3=1.24 |f1|/f=1.76
f5=2.5085 f5/f=6.1083

m	ri	di	ni	νi	
1	809.71244	16.07	1.49154	57.8	*
2	809.71734	0.99			
3	220.68091	17.06	1.69680	55.5	
4	965.56137	0.20			
5	1093.03613	5.08	1.61293	37.0	
6	59.85684	18.67			
7	162.76270	4.49	1.63854	55.4	
8	61.41639	104.66			
9	256.85666	30.00	1.80518	25.5	
10	-177.35439	1.63			
11	INF	67.56			AST
12	-123.58084	12.08	1.80518	25.5	
13	73.62199	22.25	1.72916	54.7	
14	-99.09597	0.20			
15	858.68817	22.98	1.69680	55.5	
16	-212.81665	0.20			
17	199.27482	21.65	1.69680	55.5	
18	INF	20.00			
19	INF	71.00	1.51680	64.2	
20	INF				

<非球面係数>

m	K	A4	A6	A8	A10
1	46.038429	0.103407E-6	-0.230100E-11	-0.388917E-16	0.190263E-20

[0087] <Gestalt 23 of operation> drawing 20 is the lens cross section of the gestalt 23 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 23. With the gestalt of this operation, the air gap between the still bigger 1st lens group G1 than the gestalten 21 and 22 of the above-mentioned implementation and the 2nd lens group G2 can be secured, and it is satisfactory to mirror insertion. Moreover, both the lens L3 by the side of the liquid crystal panel 3 of the 1st lens group G1 and the lens L4 of the 2nd lens group G2 are used as the aspheric lens, and the spherical aberration on a shaft, and the distortion aberration besides a shaft and high order astigmatism are amended with sufficient balance to altitude. Since L3 and L4 with the comparatively small diameter of a lens are aspheric-surface-ized with the gestalt of this operation, creation of the aspheric surface is easy.

[0088]

[A table 23]

実施の形態２３

f=40.00　θ=42.16°　R=4.5　β=14.5
f1=-69.13　f2=130.85　f3=113.66　D1=107.92
D1/f=2.70　f2/f3=1.15　|f1|/f=1.73

m	ri	di	ni	νi	
1	180.68905	22.00	1.69680	55.5	
2	206.04152	0.20			
3	110.37469	5.00	1.61293	37.0	
4	53.37385	16.72			
5	104.95392	4.03	1.52540	56.3	*
6	38.18085	107.92			*
7	438.02979	35.00	1.49154	57.8	*
8	-73.74918	1.00			*
9	INF	88.88			AST
10	-259.71093	5.28	1.80518	25.5	
11	77.06544	21.50	1.72916	54.7	
12	-130.52172	0.20			
13	966.10879	7.50	1.69680	55.5	
14	-290.87101	0.20			
15	192.38328	8.00	1.69680	55.5	
16	8665.28884	20.00			
17	INF	71.00	1.51680	64.2	
18	INF				

<非球面係数>

m	K	A4	A6	A8	A10
5	-0.768377	0.3380428-6	-0.1676908-9	-0.5355778-13	0.3187768-16
6	-0.387362	-0.7717568-6	0.3117398-9	-0.1085338-11	0.2396538-15
7	-221.366534	-0.8128048-6	0.5721138-8	-0.2038428-10	0.2490528-13
8	0.73206	0.1778628-6	0.1199818-8	0.1687848-11	-0.2517168-13

[0089] <Gestalt 24 of operation> drawing 21 shows the gestalt 24 of operation. Moreover, the numeric data of the gestalt of this operation is shown in a table 24. Drawing 22 is the example which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 21 , and let the beam of light pass. In drawing 22 , distance of the 1st lens group last side center (C1) and the center (C2) of Mirror M was set to 56.23mm. Moreover, drawing AST is arranged 1.64mm behind the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group (the 9th page of a table 24). It turns out that Mirror M can be inserted in the comparatively small gap (88.23mm) of the 1st lens group G1 and the 2nd lens group G2 at a compact. In addition, the gestalt of this operation constitutes all lenses from a spherical lens, and although distortion aberration is comparatively large as aberration drawing is shown later, it is sufficient engine performance for uses, such as a display of TV image, and since it moreover does not use the aspheric surface, it can manufacture them cheaply.

[0090]

[A table 24]

実施の形態２４

f=41.09　θ=43.82°　P=4.5　β=14.5
f1=-72.39　f2=127.06　f3=102.95　D1=88.23
D1/f=2.15　f2/f3=1.23　|f1|/f=1.76

m	r i	d i	n i	ν i	
1	230.79216	25.88	1.69680	55.5	
2	2311.34846	0.10			
3	256.97749	2.40	1.61293	37.0	
4	70.07194	16.36			
5	375.71609	2.40	1.63854	55.4	
6	52.65455	88.23			
7	479.91760	50.00	1.80518	25.5	
8	-125.41794	1.64			
9	INF	64.29			AST
10	-101.85108	13.84	1.80518	25.5	
11	85.33577	22.52	1.78400	51.1	
12	-91.14216	0.10			
13	1107.96055	7.29	1.69350	50.8	
14	-250.34875	0.33			
15	162.38709	24.48	1.69350	50.8	
16	-7552.93986	20.00			
17	INF	71.00	1.51680	64.2	
18	INF				

[0091] <Gestalt 25 of operation> drawing 23 , drawing 24 , and drawing 25 show the gestalt 25 of operation. The gestalt of this operation is a zoom lens and the focal distance is large at the order of drawing 23 - drawing 25 . Moreover, the numeric data of the gestalt of this operation is shown in a table 25. Drawing 26 (a) - drawing 26 (c) are the examples which inserted the mirror M of 45 degrees of inclinations in the lens of the same configuration as drawing 23 - drawing 25 , and let the beam of light pass. In drawing 26 , distance of the last side center (C1) of the 1st lens group G1 and the center (C2) of Mirror M was set to 53.00mm. Moreover, drawing AST is arranged 4-20mm behind the field by the side of small conjugation of the lens L4 which constitutes the 2nd lens group G2 (the 9th page of a table 25). Drawing 26 shows that Mirror M can be inserted between the 1st lens group G1 and the 2nd lens group G2.

[0092] With the gestalt of this operation, in order to change the focal distance of all lens systems, the lens L4 of the 2nd lens group G2 is independently moved in the direction of an optical axis (a of a table 25, b). Thereby, it can carry out adjustable [of the focal distance of all lens systems], with the tele cent rucksack nature by the side of a liquid crystal panel 3 maintained. And in order to compensate the image surface gap by the side of the liquid crystal panel 3 accompanying this focal distance change, the whole system of the lens groups G1 and G2 and G3 is moved in the direction of an optical axis in one to the parallel plate L9 (c of a table 25). The above zoom actuation can adjust the projection scale factor beta from 13.8 times about 11% to 15.3 times. Although moire relief of the projection image mentioned later and scale-factor adjustment of a multi-vision projector are asked for about 10% of scale-factor fine adjustment function, the zoom function of this lens fills this demand. In addition, compensation of image surface gap may use together independent migration (d6 of a table 25, drawing 23 - drawing 25 is tuned finely) of the lens group G1 with one-migration of the lens groups G1 and G2 and G3, and a thereby still better image formation property is acquired.

[0093]

[A table 25]

実施の形態２５

f=38.8～43.2 θ=44.9～42.0° F=4.5 β=15.3～13.8
f1=-85.37 f2=139.19 f3=88.93 D1=103～87
D1/f=2.65～2.01 f2/f3=1.57 | f1 | /f=2.20～1.98
f4=-1937.50 | f4 | /f=50.94～45.76

m	r i	d i	n i	ν i	
1	223.60991	18.00	1.69680	55.5	
2	815.85357	0.20			
3	218.87795	5.00	1.61293	37.0	
4	60.82318	21.82			
5	427.20443	4.00	1.63854	55.4	
6	78.31506	a			
7	1842.49361	14.00	1.80518	25.5	
8	-120.09981	b			
9	INF	62.60			AST
10	-74.15737	3.00	1.80518	25.5	
11	112.57176	26.00	1.71300	58.9	
12	-63.64452	0.20			
13	173.92879	23.00	1.67790	55.5	
14	-137.91210	0.20			
15	-519.52669	3.00	1.49154	57.8	*
16	-1100.36498	c			*
17	INF	71.00	1.51680	64.2	
18	INF				

<可変間隔>

	a	b	c
f=38.8	103.0	4.0	18.26
f=41.0	95.0	12.0	20.00
f=43.2	87.0	20.0	22.01

<非球面係数>

m	K	A 4	A 6	A 8	A 1 0
15	90.479412	-0.9432068-8	0.2898028-10	0.5478448-14	0.5665798-17
16	-2000.000000	0.2463808-6	0.3803178-10	0.2069388-13	0.3678898-17

[0094] Drawing 27 - drawing 50 are the aberration music diagrams which are the small conjugation sides corresponding to the gestalt 24 of the gestalt 1 of operation - operation respectively, and were seen. Moreover, drawing 51 - drawing 53 are the aberration music diagrams which are the small conjugation sides corresponding to each zoom condition of the gestalt 25 of operation, and were seen. Spherical aberration (1= 610nm of WL(s), 2= 546.1nm of WL(s), 1= 470nm of WL(s)) Three waves are shown and astigmatism and distortion aberration show 546.1nm (e line). Practical use is enough presented with each aberration in drawing 27 - drawing 53 .

[0095] In addition, in the gestalt of each above operation, although drawing AST was independently formed behind the lens L4 of the 2nd lens group G2, the outer diameter of the field by the side of small conjugation of a lens L4 may be substituted for it, it may be extracted according to the structure of a lens-barrel (not shown) of holding a lens L4, and may realize a function. In the gestalten 1-4 of operation especially mentioned above, and the lens configuration by which drawing is arranged just behind the 4th lens L4 like 7, 8, 22-24, such an alternative drawing means is effective. Moreover, in the gestalten 1-25 of operation, focal adjustment when the distance from a screen to the 1st lens L1 (or L0) changes has an effective method of making the variation rate of the 1st lens group G1 whole carry out in the direction of an optical axis in one, or moving the lens groups G1 and G2 and G3 in the direction of an optical axis to the parallel plate L9 in one.

[0096] Moreover, drawing AST considers as a configuration adjustable in a diameter of a opening which is [in / a camera lens etc. / conventionally] well-known in addition to the configuration which determines the diameter of a opening fixed, and you may make it change an effective F value. Since the lens which made the diameter of drawing adjustable can adjust the contrast ratio and brightness of a projection image suitably by combining with the liquid crystal panels (PDLC, DSM liquid crystal, etc.) of the type which changes electrically the dispersion condition and transparence condition of transmitted light flux so that it may explain using drawing 59 and 60 in relation to invention of the 4th and 5, it is effective.

And a contrast ratio and brightness can be electrically adjusted automatically with the means of a motor etc. based on that accommodation is possible, then the output of a photosensor which detects the brightness of outdoor daylight so that it may mention later and may be well-known in the diameter of a opening of drawing.

[0097] The projection mold display of this invention is explained below.

<1st and 2nd invention> drawing 54 is the block diagram of the projection mold display by the 1st and 2nd invention, drawing 54 (a) shows a side elevation and drawing 54 (b) shows front view. In drawing, 300 is the projection machine constituted with the case 200 and the projection lens 4. The 1st bending mirror 41 is built in the projection lens 4. Moreover, the projection machine 300 is contained in the cabinet 170, and the cabinet 170 holds the 2nd bending mirror 160 and the screen 5 of a transparency mold.

[0098] Moreover, drawing 55 expresses the internal configuration of the projection machine 300, drawing 55 (a) shows a plan and drawing 55 (b) shows front view. In drawing, 1 is the light source which consists of a lamp 120, an electrode 121 of a lamp 120, a concave mirror 130, and a condensing lens 131. As for a lamp 120, sources of the white light, such as a metal halide lamp, a xenon lamp, and a halogen lamp, are used. In drawing, the configuration which prepared the discharging gap between the electrodes 121 of a couple is drawn supposing the metal halide lamp or the xenon lamp. A concave mirror 130 has center of curvature at the point of a lamp 120 emitting light, and it is formed in order to send in the flux of light efficiently on the right-hand side of a lamp 120 all over drawing. Coating which penetrates infrared light if needed is performed to a concave mirror 130, and the rate that heat is emitted to a liquid crystal panel side is decreased. Moreover, coating which reflects infrared radiation and/or ultraviolet rays in the refracting interface of a condensing lens 131 if needed, and penetrates the light has been performed.

[0099] The filter 140 which penetrates only the light is formed in the direction of outgoing radiation from the light source 1, and dichroic mirror 14B which reflects blue glow ahead of a filter 140, and penetrates green and red light, and dichroic mirror 14R which reflects red light and penetrates green and blue glow are arranged in the mode made to intersect perpendicularly. Liquid crystal panel 3R which has the mirrors 11b and 11c which carry out total reflection of the light to the optical path of the reflected light from dichroic mirror 14R, and image display section 3r is prepared, liquid crystal panel 3B which has the mirrors 11a and 11d which carry out total reflection of the light to the optical path of the reflected light from dichroic mirror 14B, and image display section 3b is prepared, and liquid crystal panel 3G which have 3g of image display sections are prepared in the optical path of the transmitted light of both the dichroic mirrors 14B and 14R. The graphic display is omitted about the actuation circuit which displays an image on each displays 3r, 3g, and 3b of liquid crystal panels 3R, 3G, and 3B. It is surrounded by these liquid crystal panels 3R, 3G, and 3B, red and blue glow are reflected selectively, the well-known dichroic prism 15 which penetrates green light selectively is installed, and the projection lens 4 is formed in the direction of outgoing radiation of a dichroic prism 15. The projection lens 4 contains the 1st bending mirror 41 and drawing AST, and a details configuration is as explanation of a lens having described. In drawing 55 (b), the case where the inclination of 41 of a bending mirror is 45 degrees is illustrated as a typical example. In addition, the lens system before and behind the 1st bending mirror 41 is carrying out the graphic display abbreviation.

[0100] Next, actuation of the gestalt of operation is explained. With a condensing lens 131, light (outgoing radiation light of a lamp 120 and reflected light of a concave mirror 130) from the light source 1 is parallel-ized, and carries out incidence to a filter 140. A filter 140 penetrates only the light, and reflects or

absorbs unnecessary infrared rays and ultraviolet radiation. Incidence of the flux of light which penetrated the filter 140 is carried out to dichroic mirrors 14B and 14R. The illumination light is decomposed into the three primary colors of red (R), green (G), and blue (B) by dichroic mirrors 14B and 14R. Blue glow B has an optical path bent by Mirrors 11a and 11d, and is irradiated by liquid crystal panel 3B, the red light R has an optical path bent by Mirrors 11b and 11c, liquid crystal panel 3R glares, and green light G is irradiated by liquid crystal panel 3G. Thus, a liquid crystal panel is that which is illuminated with parallel light with a condensing lens 131 (telecentric lighting system), and even if an incident angle dependency is in the spectral characteristic of dichroic mirrors 14R and 14B, it can be illuminated with the light of a uniform chromaticity. Moreover, even when the incident angle dependency of the illumination light is in the display property of liquid crystal panels 3R, 3G, and 3B, since illumination light is parallel, a uniform display property is acquired within the screen of a panel.

[0101] The transmitted light modulated by the image of a liquid crystal panel is compounded with a dichroic prism 15, and is sent into the projection lens 4. 90 degrees of synthetic flux of lights are bent by the bending mirror 41, and outgoing radiation of the projection light 110 is carried out like [lens / 4 / projection] drawing 55 (b). In addition, satisfactory [at all] also except 45 degrees, the inclination of the bending mirror 41 may be set as the optimal angle, when designing the whole set in short, and it is the criteria of the modification of this invention.

[0102] In addition, the size of each image display sections 3r, 3g, and 3b of liquid crystal panels 3R, 3G, and 3B is equal, and in the case of the projection mold display of NTSC system, in the case of a HDTV method, it needs to project the image of the proportion of 4:3 so that a longitudinal direction may become horizontal respectively about the image of the proportion of 16:9. However, the lengthwise direction of a liquid crystal display screen is changed into a longitudinal direction by the 1st bending mirror 41. Then, the image display sections 3r, 3g, and 3b are arranged so that a longitudinal direction may be all in agreement with the vertical direction of the main beam of light 111 of the projection flux of light by which outgoing radiation is carried out from a projection lens, i.e., the direction, in drawing 55 (b) which shows front view. In addition, although the horizontal direction of a projection image is a longitudinal direction in NTSC system and a HDTV method, there is also a model which should make the vertical direction of a projection screen a longitudinal direction specially in the projection display for OA. In such a case, the direction of a shorter side of the screen of a liquid crystal panel should be arranged according to the vertical direction in drawing 55 (b). In addition, since the inclination of the 1st bending mirror 41 produces similarly the phenomenon in which the display direction of a liquid crystal panel interchanges as mentioned above, except 45 degrees, it should set up so that the direction of the side of liquid crystal not to twist to the inclination of this mirror but project horizontally may be doubled in the vertical direction like drawing 55 (b).

[0103] Drawing AST has the work which makes parallel the chief ray of the flux of light which determines the F value of the projection lens 4, and carries out incidence to the projection lens 4 from each point of a liquid crystal panel at a lens optical axis as mentioned above. Therefore, if the diameter of a opening of drawing AST is set up greatly and the F value of the projection lens 4 is made small, the flux of light projected on a screen 5 will increase, and brightness will go up. Moreover, if the diameter of a opening of drawing AST is made small and the F value of the projection lens 4 is enlarged, the flux of light projected on a screen 5 will decrease, brightness will fall, but since the aberration of the projection lens 4 becomes small, resolution improves. Moreover, since a chief ray is parallel as mentioned above with drawing AST,

the unevenness of an incident angle is lost to the flux of light which penetrates a dichroic prism 15, and the irregular color of the projection image by the incident angle dependency of the spectral characteristic of a dichroic prism 15 can be abolished.

[0104] Next, drawing 54 explains actuation of the whole set. The portion before the 1st bending mirror 41 (case 200) is arranged in left-hand side [center / of a screen 5] one half among the projection machines 300 in the front view (drawing 54 (b)) seen from the screen side. Outgoing radiation of the flux of light bent by the 1st bending mirror 41 within the projection lens 4 is started and carried out to vertical above as a projection light 110, as shown in a side elevation (drawing 54 (a)), the 2nd bending mirror 160 bends at a screen 5 side, and an amplification image is formed on a screen 5.

[0105] In addition, a rectangle is sufficient as the 2nd bending mirror 160, and a reflector should be located only in the incidence range of the projection light 110. Then, if the mirror of trapezoidal shape is used for drawing 54 (b) as the dashed line showed, since it is made to the minimum mirror area, it is effective in lightweight-izing of a set. Since the inclination to the optical axis of the axial outdoor daylight inside a lens system will be made smaller than the inclination to the optical axis of lens outgoing radiation light if a bending mirror is mounted in a lens as mentioned above, the 1st bending mirror 41 can be made small. And if a case 200 is contained in the left half rather than the center of a screen 5, since the portion 171 below the screen 5 of a cabinet 170 will be made small, reduction of set height H is easy.

[0106] About the point which makes depth D small, it is effective to make the angle theta 1 (drawing 54 (a)) to the vertical line of the 2nd bending mirror 160 into 45 degrees or less. For that purpose, the center line 111 of the projection flux of light in which the angle theta 2 of the base 201 of a case 200 and the base 172 (it is in agreement with a horizontal line) of a cabinet to make is shown with an alternate long and short dash line should also set up the vertical twist so that it may incline to set back. What is necessary is for that just to be theta2 >=0 degree. Although the center line of the projection light which carries out incidence to a screen 5 for convenience was drawn in drawing 54 so that it might be horizontally in agreement, it is desirable to set up so that not this limitation but the extension wire of a center line may not necessarily serve as a location of an appreciation person's eyes.

[0107] In order to make height H small, it is required to make a case 200 as thin as possible. For this reason, the optical system from the light source 1 to [the gestalt of operation of drawing 55] a dichroic prism 15 is arranged in the flat surface (drawing 55 (a)) which intersects perpendicularly with the main beam of light 111 of the outgoing radiation light of the projection lens 4, and it is the thickness Hp of a case 200. It is made small. In addition, by drawing 55 (b), 201 is the base of a case 200 and lies at right angles to the main beam of light 111 of projection light. That is, the base 201 is arranged in the field parallel to drawing 55 (a) which shows a plan. Although arrangement of the optical system which rotated 90 degrees of cases 200 to the circumference of the optical axis of the projection lens 4 is also considered using the same optic as drawing 55 , it is the width of face Wp of a case 200 in this case. Height Hp Since it is large, it applies to the configuration of drawing 54 , the height of the whole projection mold display is made small and also, and it is disadvantageous.

[0108] Moreover, the screen 5 has the proportion of 16:9 in the equipment of 4:3 and a HDTV method with the equipment of NTSC system, and the longitudinal direction is set up horizontally. If it arranges so that the longitudinal direction of the image display side of a liquid crystal panel may turn into the vertical direction in the projection machine 300 interior as shown in drawing 55 (b), since a direction is changed so that the longitudinal direction of a projection image may be in agreement with the longitudinal

direction (horizontal direction) of a screen with an echo by the 1st bending mirror 41, it is convenient. Furthermore, although drawing 54 showed the example which arranges a case 200 in the left half rather than the center of a screen 5, even if it arranges a case 200 in the right half rather than the center of a screen 5, there is no change in the effect of this invention.

[0109] It is necessary to set up suitably the angle theta 2 of the base 201 of a case 200, and the base 172 (it is made for convenience in agreement with the direction of a horizontal line by a diagram) of a cabinet 170 to make in drawing 54 for reducing the height of the whole set under the optical-system arrangement in the above cases. Using the projection lens of the gestalt 1 of operation, drawing 54 is the example which constituted equipment with a screen size of 40 inches (aspect ratio 3:4), considers as theta1=38 degree and theta2=14 degree among drawing, and is drawing by carrying out. On this condition, a set height of H= 712mm and the depth of D= 360mm were obtained. Moreover, it turned out that it becomes a height of H= 636mm, and the depth of D= 432mm by similarly considering as theta1=45 degree and theta2=0 degree on a 40 inch screen, and set height can be reduced although depth increases from the above-mentioned example. However, since a projection machine base is in agreement in it being horizontal in this example, if the assembly of a set, inspection, etc. become easy and the increment in depth can be permitted, it can be called a desirable configuration on manufacture. When the conditions (theta2 >=0 degree) which make depth of the above-mentioned set small are taken into consideration, in order to reduce the depth and the height of a set with sufficient balance, it is desirable to fill the following conditional expression.

0 degree<=theta2 <=20 degree (8)

If the lower limit of conditional expression (8) is exceeded, the depth of a set will become large superfluously. Moreover, if the upper limit of conditional expression (8) is exceeded, inconvenience, like a case 200 overflows ahead [set] across the field of a screen 5 which set height increases superfluously and where a case 200 interrupts the incoming beams to a screen 5 will arise.

[0110] <3rd invention> drawing 56 is the block diagram of the projection mold display by the 3rd invention, in drawing 56 (a), drawing 56 (b) shows front view and drawing 56 (c) shows a side elevation for a plan. In drawing, since the portion which attached the same number as drawing 54 being the same, or a considerable portion is shown, those explanation is omitted. In drawing, 41 is a bending mirror equivalent to the 1st and 1st [of invention of two] bending mirror 41 built in in the projection lens 4. Moreover, drawing 57 is the internal configuration of the projection machine 300, and the plan of the field where the optical system before the projection lens 4 has been arranged, and drawing 57 (b) of drawing 57 (a) are side elevations. In drawing, since the portion which attached the same number as drawing 55 being the same, or a considerable portion is shown, those explanation is omitted and, for 51, as for amplifier and 53, a photosensor and 52 are [a motor / ramp-control circuit, and 54] motors.

[0111] Next, actuation of the gestalt of operation is explained. Light from the light source 1 is parallel-ized with a condensing lens 131, and only the light is penetrated with a filter 140. Incidence of the flux of light which penetrated the filter 140 is carried out to dichroic mirrors 14B and 14G. The illumination light is decomposed into the three primary colors of red (R), green (G), and blue (B) by dichroic mirrors 14B and 14G. Blue glow has an optical path bent by mirror 11a, and is irradiated by liquid crystal panel 3B, red light has an optical path bent by Mirrors 11b and 11c, liquid crystal panel 3R glares, it is reflected by dichroic mirror 14G, and green light is irradiated by liquid crystal panel 3G. Thus, a liquid crystal panel is that which is illuminated with parallel light with a condensing lens 131 (telecentric lighting system),

and even if an incident angle dependency is in the spectral characteristic of dichroic mirrors 14B and 14G, it can be illuminated with the light of a uniform chromaticity. Moreover, even when the incident angle dependency of the illumination light is in the display property of liquid crystal panels 3R, 3G, and 3B, since illumination light is parallel, a uniform display is obtained within the screen of a panel.

[0112] The transmitted light modulated by the image of a liquid crystal panel is compounded with a dichroic prism 15, and carries out incidence to the projection lens 4. As mentioned above, it bends inside the projection lens 4, the mirror 41 is built in, and it has the lens system before and after the mirror (a lens system is a graphic display abbreviation). In drawing 57 (b), the case where the inclination of the bending mirror 41 was 45 degrees was illustrated as a typical example. The 90 degrees of the above-mentioned synthetic flux of lights are bent by the bending mirror 41, and outgoing radiation of the projection light 110 is carried out like [lens / 4 / projection] drawing 57 (b). In addition, the optical system before the projection lens 4 (optical system from the light source 1 to a dichroic prism 15) is arranged in the flat surface parallel to the base 201 (refer to drawing 57 (b)) of a case 200, as a plan is shown in drawing 57 (a).

[0113] Drawing AST has the work which makes parallel the chief ray of the flux of light which determines the F value of the projection lens 4, and carries out incidence to the projection lens 4 from each point of a liquid crystal panel at a lens optical axis like the 1st and 2 invention. Therefore, if the diameter of a opening of drawing AST is set up greatly and the F value of the projection lens 4 is made small, the flux of light projected on a screen 5 will increase, and brightness will go up. Moreover, if the diameter of a opening of drawing AST is made small and the F value of the projection lens 4 is enlarged, the flux of light projected on a screen 5 will decrease, brightness will fall, but since the aberration of the projection lens 4 becomes small, resolution improves. Moreover, since a chief ray is parallel as mentioned above with drawing AST, the unevenness of an incident angle is lost to the flux of light which penetrates a dichroic prism 15, and the irregular color of the projection image by the incident angle dependency of the spectral characteristic of a dichroic prism 15 can be abolished.

[0114] Next, drawing 56 explains actuation of the whole set. Among the projection machines 300, the portion before the bending mirror 41 (case 200) is arranged in left-hand side [center / of a screen 5] one half in the plan (drawing 56 (a)) which looked at equipment from the upper part, and the base 201 of a case 200 is arranged at a screen 5 and abbreviation parallel. Of the bending mirror 41, as a projection light 110, incidence is carried out on a screen 5 and, as for the flux of light bent within the projection lens 4, an amplification image is formed. With the gestalt of this operation, from the projection lens 4, the main beam of light 111 which carries out outgoing radiation advances horizontally, and carries out incidence almost at right angles to a screen 5.

[0115] If the bending mirror 41 is arranged in a lens as mentioned above, the inclination to the optical axis of the axial outdoor daylight inside a lens system can be made smaller than the inclination to the optical axis of lens outgoing radiation light. For this reason, compared with the case where a mirror is arranged to the exterior of the projection lens 4, the size of a mirror can be made small. containing a case 200 in the left half rather than the center of a screen 5 -- the transverse-plane size (W of drawing 56 (b), H) of a cabinet 170 -- almost -- the size of a screen 5, and abbreviation -- it can do equally. And depth (D of drawing 56 (c)) of a cabinet 170 can also be made small by using the projection lens 4 of a wide angle which was mentioned above.

[0116] As mentioned above, depth D can be made small, minimizing the transverse-plane sizes W and H

of equipment by arranging so that the base 201 of a case may be arranged to abbreviation parallel and the main beam of light 111 of the projection light 110 may carry out outgoing radiation to a screen 5 horizontally. The arrangement which rotated 90 degrees of cases 200 around the main beam of light 111 in drawing 56 (b) is also considered using the same projection machine as drawing 57 . arrangement of such a projection machine is also the modification of this invention -- it is natural. Moreover, although drawing 56 showed the configuration which arranges a case 200 from the center of a screen 5 to a left half side, a problem does not have the configuration arranged to a right half side, either.

[0117] Next, drawing 58 explains the modification of the 3rd invention explained above. Drawing 58 is the example which arranged two or more projection machines 300 shown in drawing 57 in all directions, and constituted the multi-vision projector. In drawing, 300a-300d are the projection machines same with having been respectively shown in drawing 57 . Although the array beside [4] vertical 3x is shown by a diagram, since two steps of projection machines 300e-300l. and the projection lenses 4e-4l. are easy, the graphic display is omitted the bottom. 5a-5l. are screens, and on each screen, the projection light which carries out outgoing radiation from the projection lenses 4a-4l. carries out incidence of it, and it forms an unit projection screen. Each projection machine is arranged so that an adjoining unit screen may arrange densely and may be formed on screen 5a-5l. The base of an each unit projection machines [300a-300l.] case is arranged like the case of drawing 56 at Screens 5a-5l. and parallel. It is the cabinet which contains each projection machines 300a-300l. 170a-170l., and holds Screens 5a-5l.

[0118] Each screens 5a-5l. may arrange a separate screen length and horizontally for every unit screen, and one is sufficient as the whole. Moreover, the screen corresponding to the set of unit screens, such as 2x2 etc. pieces, may be unified selectively (for example: {5a, 5b, 5e, 5f} and {5c, 5d, 5g, 5h}, {5i, 5j}, and {5k, 5l.} are really a screen respectively with a screen). Moreover, even if Cabinets 170a-170l. are the structure in which each could arrange the box-like thing of another object in all directions, united several adjoining pieces with box-like, and arranged these, or the structure which united the whole with box-like, they are not cared about.

[0119] As mentioned above, the multi-vision projector of drawing 58 has the transverse-plane sizes W and H equivalent to the size of a screen 5 shown in drawing 56 , and since the configuration that depth D arranged two or more small projection mold displays length and horizontally is made, the joint between unit screens is made small and, moreover, serves as equipment with small depth D. Although it is the example of the width 4x length 3, its array number of an unit screen is satisfactory even if drawing 58 is a configuration of those other than this. since the gestalt of this operation is a multi-vision configuration -- as a whole -- a super-big screen and high resolution, and high -- brightness equipment can be realized easily.

[0120] Moreover, by using the projection lenses 4a-4l. as a zoom lens in the configuration of drawing 58 , even if a difference is in the projection scale factor of each screen, it can adjust to the same projection scale factor easily, and discontinuity of the image between unit screens is made to min.

[0121] In addition, although the dichroic prism 15 in the 1st, 2, and 3 above-mentioned invention may be created with a glass material, lightweight-izing of equipment and low-pricing are possible for it by using plastic material (PMMA, PC, ZEONEX, OZ1000, ARTON, APO, etc.), as the gestalt 13 of operation described.

[0122] Moreover, the size of a projection image can be adjusted now by considering as the zoom lens which stated the projection lens 4 with the gestalt 25 of operation. Since the lenticular screen with which a

screen 5 has periodic structure horizontally is used and the liquid crystal panel 3 has the periodic structure by the matrix-like electrode so that it may be well-known, periodic structure is observed by the amplification projection image to level and a perpendicular direction. Pinstriped moire occurring and becoming the hindrance of image appreciation among such periodic structures, by interference of the level period structure of a screen 5 and a liquid crystal projection image, is known. As for this pinstriped moire, it is well-known that the effect on lowering and image appreciation can be minimized for visibility by optimizing the ratio of the level period of a screen 5 and the level period of the projection image of a liquid crystal panel. Then, the projection lens 4 is used as a zoom lens as mentioned above, and if a projection scale factor is adjusted, the moire on which a projection image is overlapped can be adjusted to the condition of being the hardest to be visible.

[0123] TN better known than before to the liquid crystal panel used for the <4th invention> projection mold display (Twisted Nematic) Liquid crystal, and PDLC (Polymer Dispersed Liquid Crystal) and DSM (Dynamic Scattering Mode) The liquid crystal material based on various kinds of principles of operation is applicable including liquid crystal. As for Above PDLC and DSM liquid crystal, it is known that a dispersion condition and a transparence condition will change [the condition of liquid crystal] according to the applied voltage to a pixel. Therefore, since a liquid crystal panel is intercepted in the state of dispersion by the drawing AST by which the projection flux of light was prepared in the interior of the projection lens 4 of drawing 55 when forming a projection image with the projection lens 4, a projection image serves as dark level. On the other hand, when a liquid crystal panel is in a transparence condition, since the parallel flux of light which penetrated the panel penetrates the projection lens 4 almost without a loss [****] and is projected, a projection image serves as ** level.

[0124] It is a projection mold display using Above PDLC and DSM liquid crystal, and it is the feature on the configuration of the projection mold display of the 4th invention to constitute so that it can carry out adjustable [of the diameter of a opening of drawing AST]. The new effect brought about by this configuration is explained below using drawing 59 which is a mimetic diagram explaining the principle of the 4th invention. The entrance pupil of the projection lens 4 which extracts EP by drawing 59 and changes with the diameter of a opening of AST is shown, and the liquid crystal panel 3 is made only into one sheet on [of explanation] expedient. Drawing 59 (b) is the case where extracted and the diameter of a opening of AST is enlarged, and drawing 59 (a) shows the case where extracted and the diameter of a opening of AST is made small.

[0125] Drawing 59 is explained supposing the liquid crystal (PDLC, DSM, etc.) of the type which changes transparence / dispersion condition as liquid crystal. When a liquid crystal panel 3 is in a transparence condition, the illumination light Iin is the parallel transmitted light It. It becomes, and an entrance pupil EP is penetrated without a loss [****], and it becomes the projection flux of light. On the other hand, when a liquid crystal panel 3 is in a dispersion condition, the transmitted light is the diffused-light bunch Id. It becomes and is the acceptance angle theta 0 of an entrance pupil. Although the inner flux of light is penetrated and turns into the projection flux of light, the flux of light besides the acceptance angle theta 0 shown with the slash is not projected. By changing the diameter of a opening of an entrance pupil EP by accommodation of the diameter of a opening of drawing AST shows that projection luminous intensity (dark level) in case a liquid crystal panel 3 is in a dispersion condition changes, and a contrast ratio (brightness ratio of **/dark of a projection image) changes.

[0126] Moreover, since the illumination light (Iin of drawing 59) of a liquid crystal panel is not a perfect

parallel light actually, projection display brightness (** level) in case a liquid crystal panel is in a transparence condition will also change by changing the diameter of a opening of drawing AST. The contrast ratio of a projection image and an intensity level can be adjusted the optimal according to liking of the optical property of a liquid crystal panel and an appreciation person by constituting so that it can more specifically carry out adjustable [of the diameter D of a opening of the drawing AST in the projection lens mentioned above (effective F value of a projection lens)] in well-known drawing wing 42 grade. in addition, the thing which it is possible to mainly change the brightness (** level) of a projection image, and is set as the application object of this invention since the illumination light is not completely parallel as mentioned above even when a liquid crystal panel is not the type which changes transparence / dispersion condition like TN liquid crystal -- it is natural. Moreover, if the diameter of a opening of drawing AST is made small, since the aberration of a projection lens will become small, a projection image is formed more in high resolving.

[0127] In addition, the gestalt of implementation of the above invention [4th] was explained as one example of the configuration of drawing 55 which shows the 1st and the projection machine configuration of invention of two. However, in invention of the 1st and 2, the 1st bending mirror 41 in the projection lens 4 which was an indispensable component is not necessarily required, and is good also as a projection lens which has well-known straight pipe lens-barrel structure. Moreover, the frontal system not only using a rear method but a reflective mold screen is sufficient also as a projection method.

[0128] According to the output of the photosensor which detects the brightness of the outdoor daylight of the location on which equipment was put in the diameter of a opening of drawing AST, and/or the actuation power of a lamp, it controls by the projection mold display by the <5th invention> 5th invention, and the brightness of a projection image and/or a contrast ratio are automatically adjusted corresponding to the condition of outdoor daylight. The fundamental concept which adjusts the diameter of a opening of drawing AST is the same as that of the 4th above-mentioned invention, drawing 60 (b) is the case where extracted and the diameter of a opening of AST is enlarged, and drawing 60 (a) shows the case where extracted and the diameter of a opening of AST is made small. In this 5th invention, the contrast ratio of a projection image and an intensity level are adjusted the optimal by extracting through a motor 54, driving a wing 42, and making the diameter D of a opening adjustable.

[0129] Having used for explanation of the 3rd invention about actuation of the projection machine by the 5th invention and common drawing 57 explain. A photosensor 51 detects the outdoor daylight of the environment where the projection mold display was installed, and outputs an electrical signal according to the brightness of outdoor daylight. Amplifier 52 amplifies the output of a photosensor, and it generates the driving signal of a motor 54, and the actuation power signal of a lamp 120 continuously in a motor / ramp-control circuit 53. A motor 54 is extracted according to the output of a control circuit 53, and adjusts the diameter of a opening of AST. It extracts as it extracts, the diameter of a opening of AST is enlarged and outdoor daylight specifically becomes dark, when outdoor daylight is bright, and the diameter of a opening of AST is made small. When the material of the type which changes transparency/dispersion conditions, such as PDLC and DSM, as liquid crystal of liquid crystal panels 3R, 3G, and 3B is used, by control of such drawing AST, the projection image of high brightness is formed lowering a contrast ratio and resolution, when outdoor daylight is bright, and when outdoor daylight is dark, a high contrast ratio and the projection image of high resolution can be formed more by low brightness. In addition, when the liquid crystal of the type which does not change a transparency/dispersion condition like TN liquid crystal

as liquid crystal of liquid crystal panels 3R, 3G, and 3B is used, only the brightness and resolution of a projection image can mainly be controlled by diameter change of a opening of drawing AST.

[0130] The actuation power of a lamp 120 is also controlled by the equipment of drawing 57 with the output of a control circuit 53 with the diameter control of a opening of drawing AST. That is, when outdoor daylight is bright, the actuation power of a lamp 120 is increased and it is made the projection image of high brightness more, and when outdoor daylight is dark, the actuation power of a lamp 120 is lowered and it is made the projection image which is not more dazzling as for low brightness. In addition, both the above throttling control and lamp actuation power control are good in a line, and at least one of the two does not matter.

[0131] Next, drawing 56 explains mounting of the above-mentioned photosensor 51. At the edge of a screen 5, the photosensor 51 in drawing turned the outside of a cabinet 170, and arranges the light-receiving side. Thereby, the brightness of the outdoor daylight of the field of a screen 5 can be detected, and processing after the amplifier 52 of drawing 57 can be performed.

[0132] In addition, the gestalt of implementation of the above invention [5th] explained drawing 57 which shows the 3rd projection machine configuration of invention as one example of a configuration. However, in the 3rd invention, the mirror 41 in the projection lens which was an indispensable component is not necessarily required, and is good also as a projection lens which has the straight pipe lens-barrel structure which does not build in a mirror. Moreover, not only a rear method but a frontal system is sufficient also as a projection method. In frontal-system projection, one gestalt of whether it installs in some of whether a photosensor 51 is installed in a reflective mold screen, cases 200, or near of those is suitable.

[0133]

[Effect of the Invention] According to the 1st invention, the 1st bending mirror is arranged inside a wide angle projection lens. And the projection optical system before the 1st bending mirror is arranged in a right hand or the direction of a left hand seen from the transverse-plane center of a screen. Since it considered as the configuration which bends the projection light started upward by the 1st bending mirror to an abbreviation horizontal direction by the 2nd bending mirror and the orientation of the liquid crystal panel screen was set up further appropriately, the small rear method projection mold display of the height direction and the depth direction is realizable.

[0134] According to the 2nd invention, the 1st bending mirror is arranged inside a wide angle projection lens. And the case which contained the projection optical system before the 1st bending mirror in the right hand or the direction of a left hand seen from the transverse-plane center of a screen is arranged. It considers as the configuration which bends the projection light started upward by the 1st bending mirror to an abbreviation horizontal direction by the 2nd bending mirror. the inside of the flat surface which intersects perpendicularly the optical system from the light source in the case of a projection machine to a dichroic prism with the main beam of light of projection lens outgoing radiation light -- arranging -- this flat surface and abbreviation -- by setting up appropriately the angle at an parallel case base and the base of a cabinet to make The small rear method projection mold display of the height direction and the depth direction is realizable.

[0135] According to the 3rd invention, it considers as the configuration which bends inside a projection lens, arranges a mirror, bends the main beam of light of the projection light which carries out outgoing radiation from a projection lens by the bending mirror to an abbreviation horizontal direction, and carries

out incidence to the screen of a transparency mold. the inside of the flat surface which intersects perpendicularly the optical system from the light source in the case of a projection machine to a dichroic prism with the main beam of light of projection lens outgoing radiation light -- arranging -- this flat surface and abbreviation -- an parallel case base and an parallel screen -- abbreviation -- by constituting so that it may become parallel The transverse-plane size of equipment is made to the size and abbreviation EQC of a screen, and, moreover, a projection mold display with short depth can be realized.

[0136] Moreover, lightweight-izing of equipment and low-pricing are realizable by constituting the dichroic prism for color composition from plastic material. Furthermore, depth can realize a multi-vision projection mold display with the joint small small moreover between unit screens by arranging two or more projection machines in all directions so that the unit screen projected by the projection light of each projection machine may arrange densely. Furthermore, the moire on which a projection image is overlapped can be adjusted to the low check-by-looking condition which is satisfactory practically by using the zoom lens as a projection lens which can adjust a projection scale factor. Moreover, by using each projection lens of a multi-vision projection mold display as a zoom lens, even if the difference in manufacture is in the projection scale factor of each unit screen, it can adjust to the same projection scale factor.

[0137] According to the 4th invention, the materials (PDLC, DSM liquid crystal, etc.) of the type which changes the transparence / dispersion condition of a panel as a liquid crystal material of a liquid crystal panel are used. Since it can carry out adjustable [of the contrast ratio and brightness of a projection image] by constituting so that an amplification projection image may be formed with the projection lens which can carry out adjustable [of the diameter of a opening of drawing], and changing the effective F value of a projection lens by accommodation of the opening system of drawing According to liking of the optical property of a panel and an appreciation person, an image can be appreciated in the optimal condition.

[0138] Since according to the 5th invention it constituted so that the brightness of outdoor daylight might be detected, a motor might be driven according to the output of a sensor and the diameter of a opening of drawing in a projection lens might be controlled by the photosensor, according to an outdoor daylight condition, the projection mold display which can regulate brightness, resolution, and a contrast ratio automatically is realizable. Moreover, corresponding to outdoor daylight, the brightness of a projection image can be automatically adjusted by making adjustable actuation power of the lamp which illuminates a liquid crystal panel according to the output of this photosensor.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the cross section of the retro focus mold lens by the gestalt 1 of operation.

[Drawing 2] It is the cross section of the retro focus mold lens by the gestalt 1 of operation.

[Drawing 3] It is the cross section of the retro focus mold lens by the gestalt 2 of operation.

[Drawing 4] It is the cross section of the retro focus mold lens by the gestalt 3 of operation.

[Drawing 5] It is the cross section of the retro focus mold lens by the gestalt 3 of operation.

[Drawing 6] It is the cross section of the retro focus mold lens by the gestalt 4 of operation.

[Drawing 7] It is the cross section of the retro focus mold lens by the gestalt 4 of operation.

[Drawing 8] It is the cross section of the retro focus mold lens by the gestalt 5 of operation.

[Drawing 9] It is the cross section of the retro focus mold lens by the gestalt 5 of operation.

[Drawing 10] It is the cross section of the retro focus mold lens by the gestalt 6 of operation.

[Drawing 11] It is the cross section of the retro focus mold lens by the gestalt 6 of operation.

[Drawing 12] It is the cross section of the retro focus mold lens by the gestalt 7 of operation.

[Drawing 13] It is the cross section of the retro focus mold lens by the gestalt 7 of operation.

[Drawing 14] It is the cross section of the retro focus mold lens by the gestalt 8 of operation.

[Drawing 15] It is the cross section of the retro focus mold lens by the gestalt 8 of operation.

[Drawing 16] They are the gestalten 9-12 of operation, and the cross section of the retro focus mold lens by 14-20.

[Drawing 17] They are the gestalten 9-12 of operation, and the cross section of the retro focus mold lens by 14-20.

[Drawing 18] It is the cross section of the retro focus mold lens by the gestalt 13 of operation.

[Drawing 19] It is the cross section of the retro focus mold lens by the gestalten 21 and 22 of operation.

[Drawing 20] It is the cross section of the retro focus mold lens by the gestalt 23 of operation.

[Drawing 21] It is the cross section of the retro focus mold lens by the gestalt 24 of operation.

[Drawing 22] It is the cross section of the retro focus mold lens by the gestalt 24 of operation.

[Drawing 23] It is the cross section of the retro focus mold lens by the gestalt 25 of operation.

[Drawing 24] It is the cross section of the retro focus mold lens by the gestalt 25 of operation.

[Drawing 25] It is the cross section of the retro focus mold lens by the gestalt 25 of operation.

[Drawing 26] It is the cross section of the retro focus mold lens by the gestalt 25 of operation.

[Drawing 27] They are many aberration drawings of the retro focus mold lens by the gestalt 1 of operation.

[Drawing 28] They are many aberration drawings of the retro focus mold lens by the gestalt 2 of operation.

[Drawing 29] They are many aberration drawings of the retro focus mold lens by the gestalt 3 of operation.
[Drawing 30] They are many aberration drawings of the retro focus mold lens by the gestalt 4 of operation.
[Drawing 31] They are many aberration drawings of the retro focus mold lens by the gestalt 5 of operation.
[Drawing 32] They are many aberration drawings of the retro focus mold lens by the gestalt 6 of operation.
[Drawing 33] They are many aberration drawings of the retro focus mold lens by the gestalt 7 of operation.
[Drawing 34] They are many aberration drawings of the retro focus mold lens by the gestalt 8 of operation.
[Drawing 35] They are many aberration drawings of the retro focus mold lens by the gestalt 9 of operation.
[Drawing 36] They are many aberration drawings of the retro focus mold lens by the gestalt 10 of operation.
[Drawing 37] They are many aberration drawings of the retro focus mold lens by the gestalt 11 of operation.
[Drawing 38] They are many aberration drawings of the retro focus mold lens by the gestalt 12 of operation.
[Drawing 39] They are many aberration drawings of the retro focus mold lens by the gestalt 13 of operation.
[Drawing 40] They are many aberration drawings of the retro focus mold lens by the gestalt 14 of operation.
[Drawing 41] They are many aberration drawings of the retro focus mold lens by the gestalt 15 of operation.
[Drawing 42] They are many aberration drawings of the retro focus mold lens by the gestalt 16 of operation.
[Drawing 43] They are many aberration drawings of the retro focus mold lens by the gestalt 17 of operation.
[Drawing 44] They are many aberration drawings of the retro focus mold lens by the gestalt 18 of operation.
[Drawing 45] They are many aberration drawings of the retro focus mold lens by the gestalt 19 of operation.
[Drawing 46] They are many aberration drawings of the retro focus mold lens by the gestalt 20 of operation.
[Drawing 47] They are many aberration drawings of the retro focus mold lens by the gestalt 21 of operation.
[Drawing 48] They are many aberration drawings of the retro focus mold lens by the gestalt 22 of operation.
[Drawing 49] They are many aberration drawings of the retro focus mold lens by the gestalt 23 of operation.
[Drawing 50] They are many aberration drawings of the retro focus mold lens by the gestalt 24 of operation.
[Drawing 51] They are many aberration drawings of the retro focus mold lens by the gestalt 25 of operation.
[Drawing 52] They are many aberration drawings of the retro focus mold lens by the gestalt 25 of operation.
[Drawing 53] They are many aberration drawings of the retro focus mold lens by the gestalt 25 of

operation.

[Drawing 54] It is the whole projection mold display block diagram by the 1st invention, the 2nd invention, and the 4th invention.

[Drawing 55] It is the block diagram of the projection machine which constitutes the projection mold display by the 1st invention, the 2nd invention, and the 4th invention.

[Drawing 56] It is the whole projection mold display block diagram by the 3rd invention and the 5th invention.

[Drawing 57] It is the block diagram of the projection machine which constitutes the projection mold display by the 3rd invention and the 5th invention.

[Drawing 58] It is the whole multi-vision projection mold display block diagram by the 3rd invention.

[Drawing 59] In the 4th invention, it is explanatory drawing of the effect in the case of making adjustable the diameter of a opening of drawing of a projection lens.

[Drawing 60] In the 5th invention, it is explanatory drawing of the effect in the case of making adjustable the diameter of a opening of drawing of a projection lens.

[Drawing 61] It is the block diagram of the projection machine of the conventional liquid crystal projection mold display.

[Drawing 62] It is the block diagram of the projection machine of the conventional liquid crystal projection mold display.

[Drawing 63] It is the conventional projection mold display whole block diagram.

[Description of Notations]

3R, 3G, 3B A liquid crystal panel, 4 A projection lens, 5 Transparency mold screen, 15 A dichroic prism, 41 The 1st bending mirror, 51 A photosensor, 52 Amplifier, 53 A motor / ramp-control circuit, 54 A motor, 160 The 2nd bending mirror, 170 A cabinet, 200 A case, 300 A projection machine, M A bending mirror, AST It extracts and is G1. The 1st lens group, G2 The 2nd lens group, G3 The 3rd lens group.

[Translation done.]